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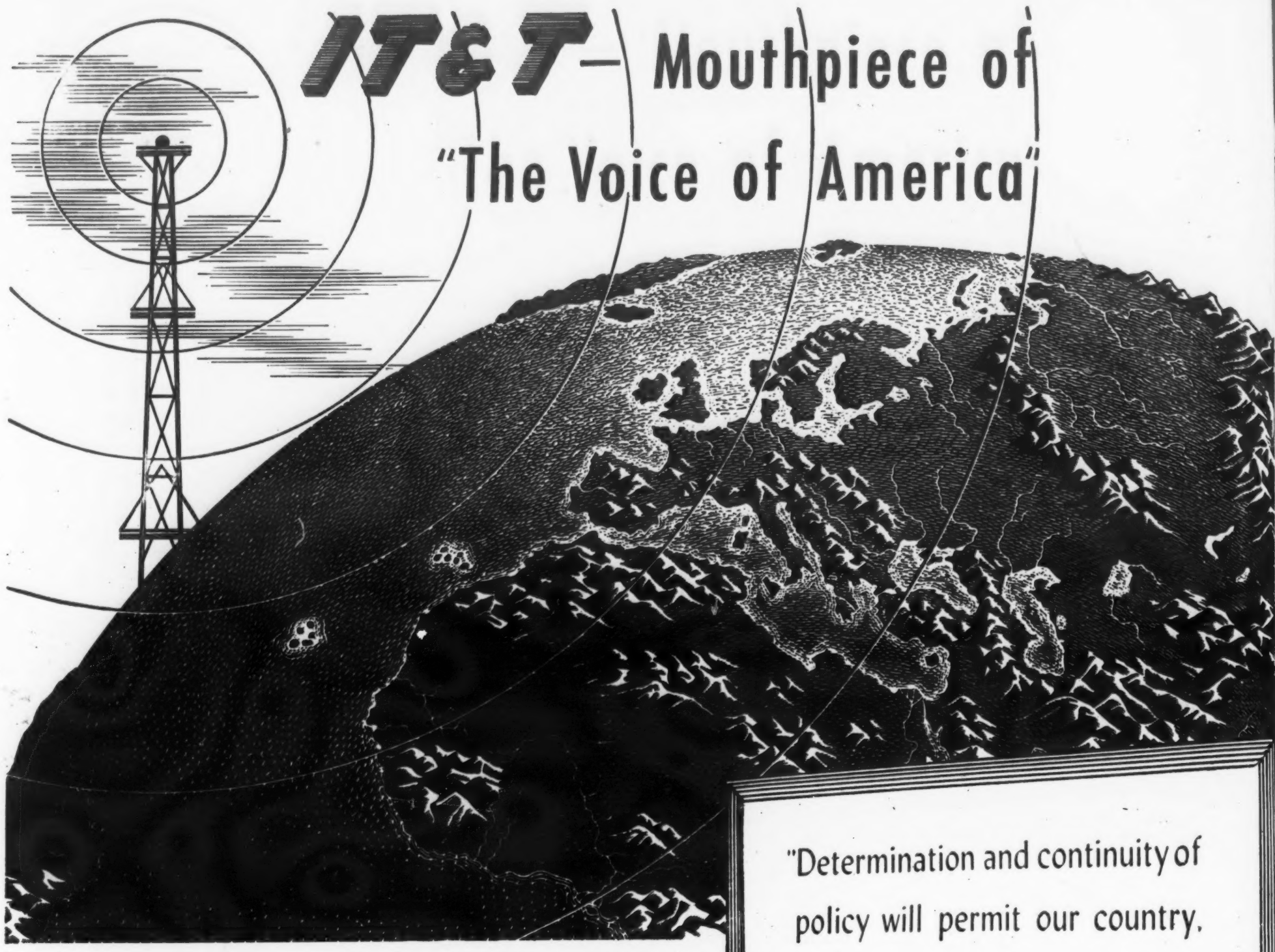

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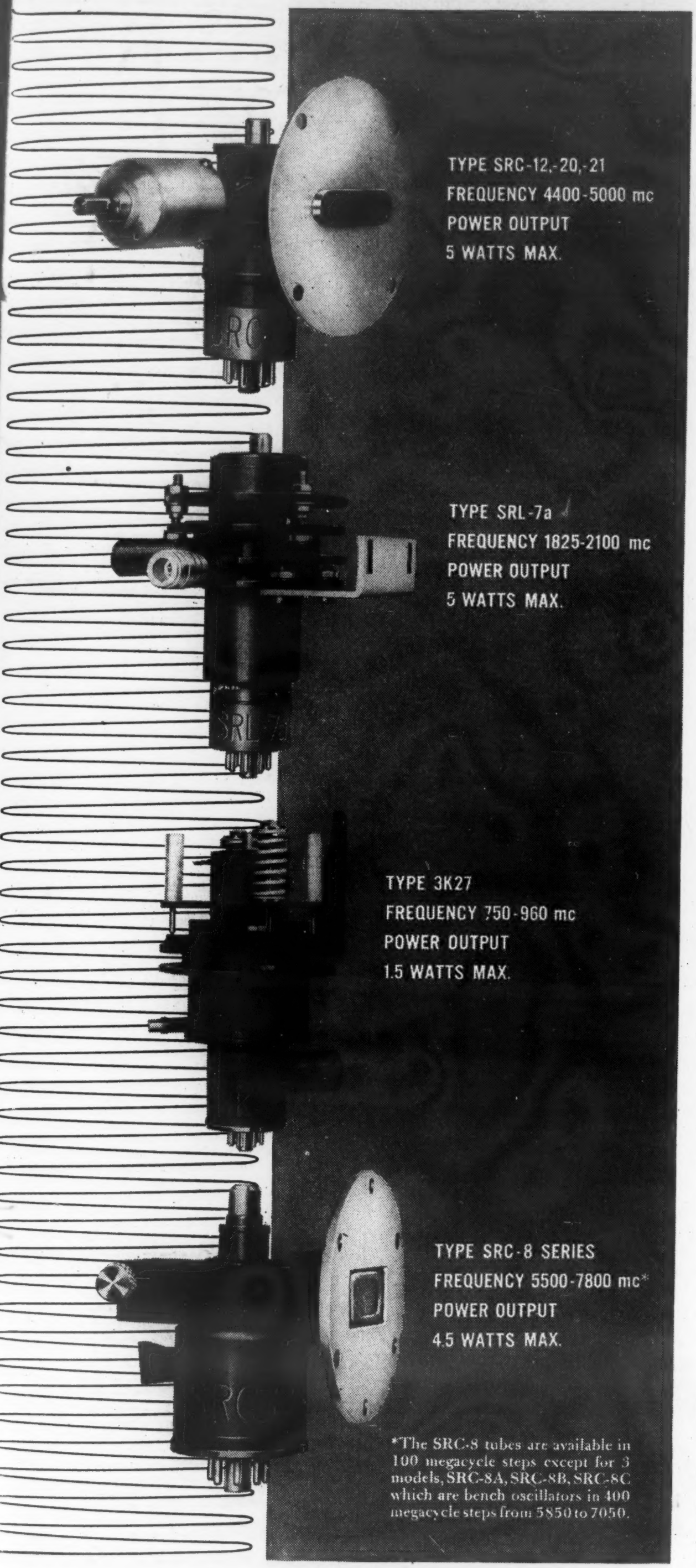
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POWER OUTPUT
5 WATTS MAX.
TYPE SRL-7a
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POWER OUTPUT
5 WATTS MAX.
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FREQUENCY 750-960 mc
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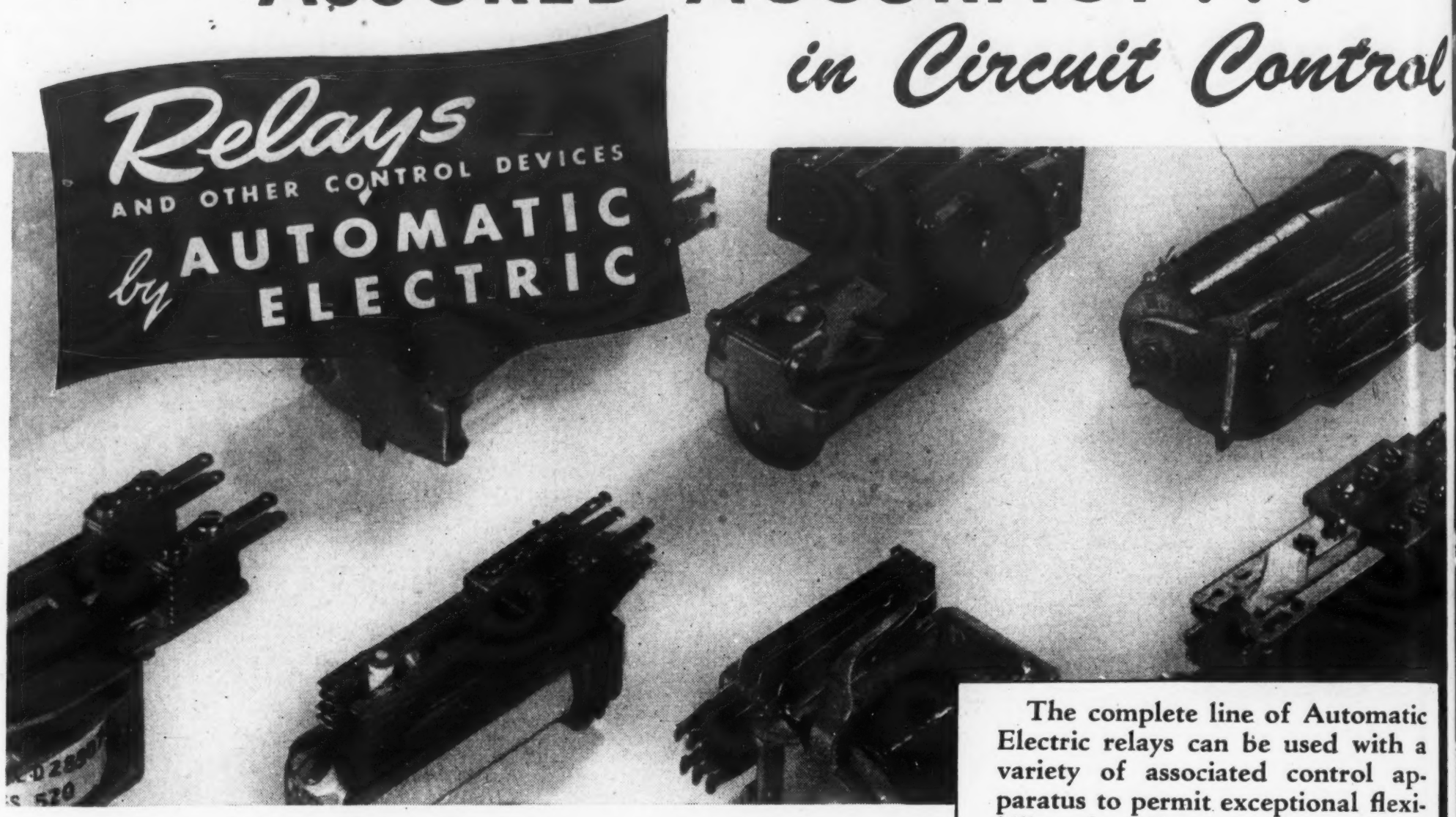

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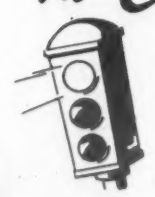

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Journal of the Armed Forces Communications Association — Dedicated to Military Preparedness

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Now that SIGNALS is the journal equally of all the communications Services the cover colors will alternate with successive issues between the different Services. The cover colors used approximate the official Service colors as closely as standard printing inks will allow.

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THE COVER

In the joint Army and Air Force world-wide photography contest, sponsored by the Army's Office of Special Services, our cover picture was a prize winner in Category A, Mission and Duties of the Services. The picture was taken by Major Sidney A. Miller. No photographic data was submitted.

The hard-won town of Bastogne, Belgium.

First Army's ETO Signal Operations

By Col. Grant Williams
Signal Officer, First Army

The commander of the German forces facing our First Army on the 31st of July, 1944 was Field Marshal von Kluge. At 1045 on that day he phoned Hitler's personal representative, General Warlimonts, and told him he thought Villedieu les Poeles and Avranches could be held by German forces. What he didn't *yet* know was that the night before, hours before the conversation, First Army troops had captured those towns and advanced miles beyond them.

The situation for the German commander was confused. He didn't know what was going on. One of the greatest military machines ever built was floundering and stumbling for lack of communications. The Germans had been in full possession of the territory for several years. They had months in which to prepare their communications. Yet, to quote Von Kluge,

"—the loss of numerous signal installations makes an orderly command extremely difficult."

Knowing what we know now, that was a gross understatement. Perhaps we will never understand why or how the German communications failed so completely.

Four and a half months later, hundreds of miles to the east, von Rundstedt threw his forces against the VIII and V Corps of the First Army in the Ardennes. It was the German final bid. Von Rundstedt's own words to his men in a dramatic Order of the Day were,

"We gamble everything now—we cannot fail."

The German Commander had been collecting and conserving infantry, armor, artillery, air power, supplies —everything necessary to make a final attempt to avert disaster which was appearing more and more inevitable. Other sectors of the German front had been weakened. Troops had been drawn from the east, from the north and south, and from Norway, for this all-out counterattack.

On December 16 they hit the northern portion of the VIII Corps' broad front and drove a wedge between our V and VIII Corps nearly 50 miles deep.

Not once during the counterattack and while the Corps remained under First Army control, was First Army Headquarters out of communications with the VIII Corps Headquarters. Teletype communication was continuous. Wire communication was in to the VIII Corps without interruption

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Villedieu and Avranches could be held, Kluge reported . . .

except for the few minutes required to make cutovers to alternate circuits.

The two headquarters were kept "talking" to one another over rehabilitated commercial underground cable circuits, open wire lines, and rapidly laid spiral-4 cable. Communication between the VIII Corps and the completely surrounded 101st Airborne Division at Bastogne was maintained by use of radio-link carrier-terminal equipment.

Also during this counteroffensive, First Army Headquarters was never out of communications with its other Corps, the V and the VII, nor with Army Reserve, nor the supporting Air Force, nor with the armies on its flanks, with Army Group and Advance Section, Communications Zone.

Wire communications were established promptly with all essential Army troop units as they were relocated and regrouped after the hurried moves caused by the counterattack.

Communications below Corps Headquarters were difficult during this operation, but never did we have a failure approaching that which von Kluge experienced.

Our signal doctrines and techniques met the "acid" test. We were forced to adapt ourselves quickly to meet a situation not of our own choosing.

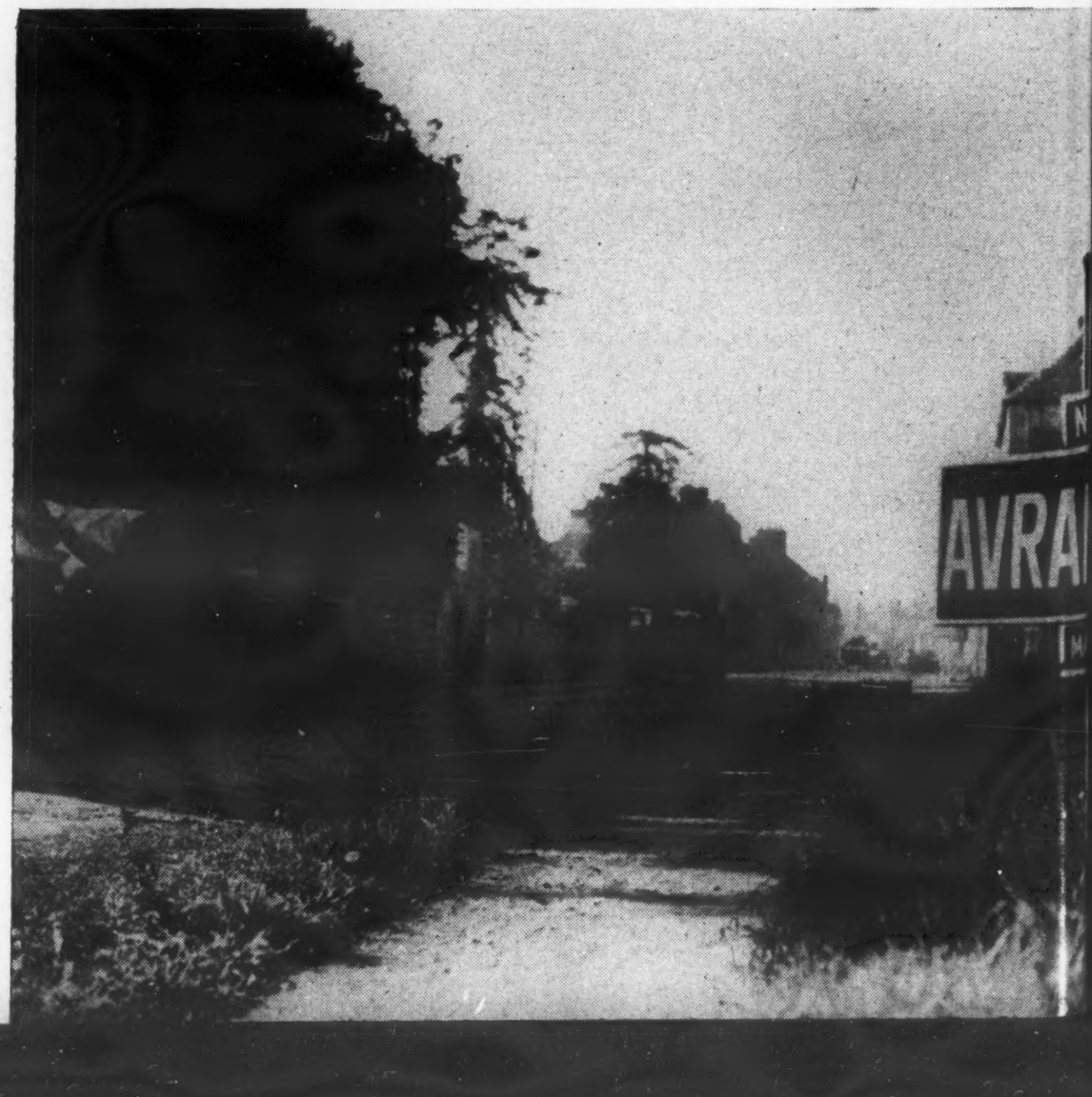
Four moves of echelons of Army Headquarters were made in the first seven days of the attack. Over 1300 miles of spiral-4 cable and field wire were laid by the Army Signal Construction Battalions during the attack, and additional rehabilitated commercial cable facilities were put into service. Radio nets were augmented. Motor messenger routes were expanded. Signal troops worked around the clock.

These experiences with communications in the First Army during the Battle of the Bulge were not unusual. From the coast of Normandy to the Elbe River, First Army Signal Corps personnel met the challenge. Communications were installed and maintained under almost every conceivable condition.

During the operations on the continent the two construction battalions of First Army ran over 1000 miles of spiral-4 cable and 250 miles of field wire per month. They rehabilitated miles of French and German open wire lines and underground cable. They crossed the Rhine River with cable in seven places. The first two of these were to provide Division Headquarters with communications to their Corps Headquarters, and were installed and circuits operating within two days.

During the battle of the Ruhr pocket First Army communications were maintained from Army Headquarters at Marburg, Germany east 150 miles to the V and VII Corps Headquarters, and west over 100 miles to the III and XVIII Airborne Corps Headquarters. Radio link repeater stations and spiral-4 carrier repeater stations were so many and

. . . he didn't know that Americans had taken these towns.



spread so thin that many were operated twenty-four hours a day by one technician and a basic. The First Army communications network covered nearly 25,000 square miles, or an area greater than the State of West Virginia.

Pre-invasion Preparations

The preparations for signal communications for the First Army's part in the invasion of the continent were started in the United States. Personnel and equipment to be used in the operation converged in England late in the fall of 1943.

The First Army was the only American Army scheduled to take part in the landings and initial combat in the invasion of Europe. Hence, there was no need for an American Army Group or group headquarters. Most of the detailed planning for the American part in the invasion was the responsibility of the Commanding General, First Army.

To carry out this planning a First Army planning board was established as part of the planning board of the British 21st Army Group.

By May of 1944 all serious problems pertaining to training, supply, and personnel had been ironed out, and First Army had completed operations plan "NEPTUNE." This plan covered the part the American Army was to play in the invasion of Europe and was based upon the allied plan for this operation, "OVERLORD."

This mission of the Signal Corps in the operation was to provide signal communications and other signal services for the First United States Army for an assault on the continent, the capture of Cherbourg, and the movement inland. The signal mission actually was complicated by several special features. Communications had to be supplied for two groups of assault forces during mounting, while afloat, during the assault, and during subsequent phases which would initially require wire communications across an estuary. This was because the two forces would probably be separated by an enemy controlled land area for some time.

Execution of the Assault

The mounting of the assault was exceptionally well planned considering the small area and large number of troops involved. The Army and Corps assault headquarters moved direct to headquarters ships while division assault headquarters moved to a concentration area near the ships. Signal communications between ships, concentration areas, and residue elements at old locations were handled through special Signal Centers at Portsmouth and Plymouth. The Joint Signal Board of the 21st Army Group coordinated the establishment of these Signal Centers primarily for combined use. All traffic for the United Kingdom was routed through the Portsmouth Signal Center while afloat, during the assault, and for sometime afterwards.

Fortunately, the radio equipment used in the landing operations was very dependable. Vehicles and all signal equipment which might be affected by moisture had been waterproofed. This practice was invariable and paid handsome dividends. Many vehicles with installed radio equipment had to be driven through water several feet deep. Once on shore vehicles and radios were quickly dewaterproofed sufficiently to permit operation. Radio equipment was found to be undamaged in practically 100% of the cases.

After reaching the beach, headquarters of assault units entered the usual Army, Corps, and Divisional Command and point-to-point radio nets. Forward troops made excellent use of frequency modulated voice radio equipment. Upon landing, the signal detachment of the engineer special brigades immediately entered the regimental combat team R/T and W/T nets. At the same time shore Navy signal detachments established a Beachmaster's Boat Control Net and a Beach Net. During the assault the First Army Headquarters ship entered two 21st Army Group Command Nets and established three First Army Command Nets. The first of these nets included the Corps Headquarters and the Plymouth Signal Center. The second covered an antiaircraft brigade and miscellaneous First Army units. The third included the three Engineer Special Brigades taking part in the operation.

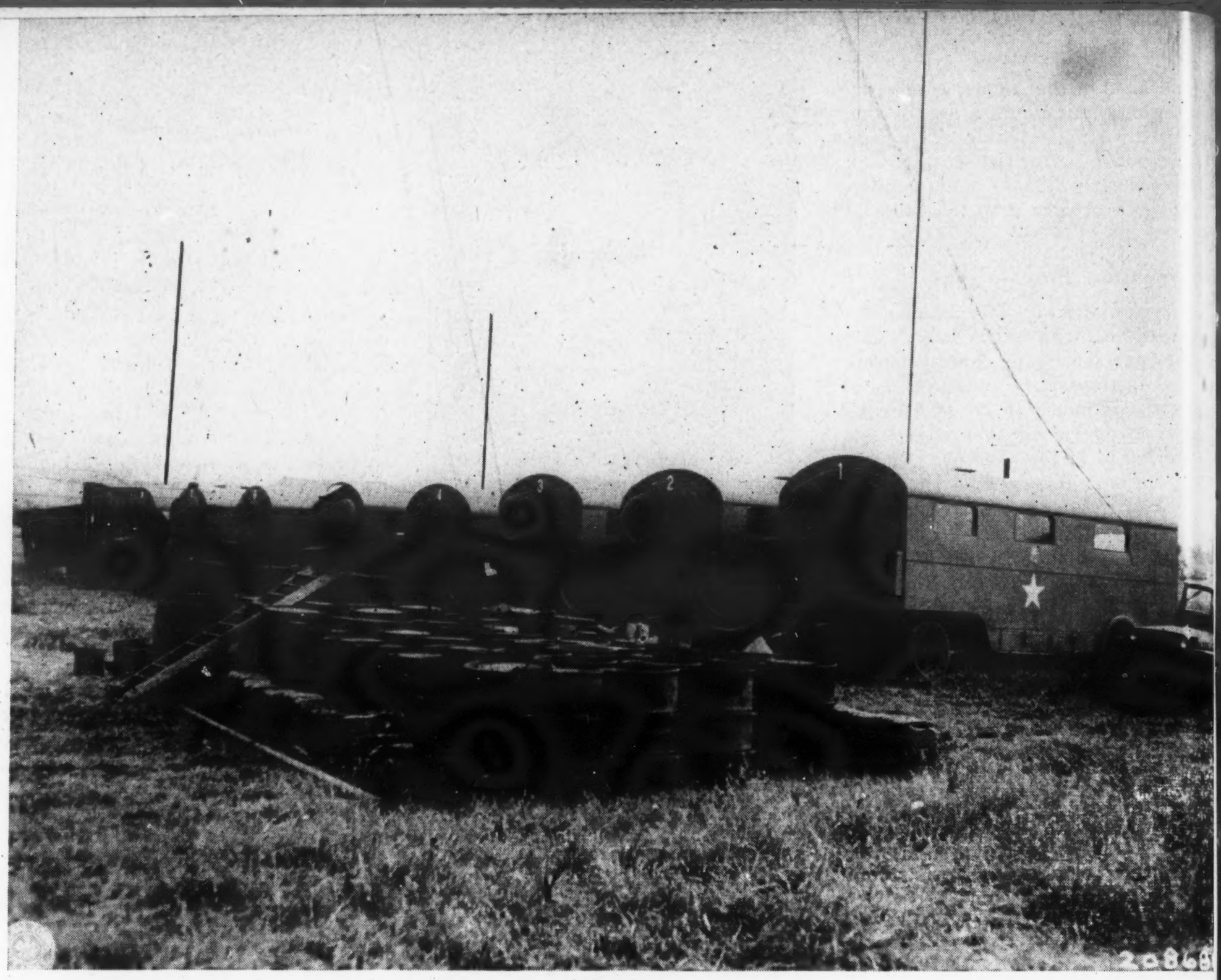
In considering communications for an amphibious operation, an important requirement is dependable ship-to-shore communications for Naval Fire Control. This problem received much attention during the pre-invasion planning days. Since Army Artillery support would be lacking, heavy Naval Gunfire support would be needed to augment air bombardment. Detailed planning resulted in excellent communications being established by Naval Shore Fire Control parties which accompanied the initial assault troops ashore. Contact with Naval vessels was established immediately after the parties were ashore, and many predetermined targets as well as targets of opportunity were successfully shelled. Even weeks later, in a battle near Carentan, and

Colonel Grant A. Williams

Enlisting in the Army in 1923 Col. Williams was commissioned by competitive examination in 1926 as a Second Lieutenant of Cavalry. In 1936 he was ordered to the Mechanized Cavalry at Fort Knox, Kentucky.

As a result of his deep interest in the development of Signal communications equipment for the Mechanized Cavalry he was detailed to the Signal Corps in 1940. Shortly thereafter he became Signal Officer of the 1st Armored Division. He was with that division when it went overseas in May 1942, trained in North Ireland, participated in the landing at Oran, North Africa, and moved on to Tunisia to meet the German counter-invasion there. During the latter campaign he became Chief of Staff of the division, and at the end of the campaign moved up as Signal Officer, II Corps. He participated in the assault on Sicily and after the conquest of that island returned to England where he was assigned as Signal Officer of the First Army. He has held that position to date.

Col. Williams participated in the Normandy invasion and all subsequent campaigns in northern Europe. After the German surrender he moved with First Army HQ, by air, to Fort Jackson, S.C., and by air again to Manila, P.I. where First Army began planning for the invasion of Tokyo. After the Japanese surrender Col. Williams returned with the First Army to Fort Bragg, N.C., and later moved with it to its prewar post at Governors Island, N.Y.



Mobile communications unit in Germany.

also during the attack on Cherbourg, Naval Gunfire support was furnished in this manner.

Wire Communication in the Assault

During the initial phase of the assault, wire was used very little. It had been planned to have the Joint Assault Signal Companies lay field wire in the water between the troops on the beach and their headquarters ships. This idea was abandoned because of the congested traffic both in the water and on the beach. On shore within the first 24 hours the Engineer Shore Company Signal Detachments had tied in field wire laid by infantry battalions along their axis of advance and had run laterals between shore detachments. Shortly afterwards the Signal Sections of the Engineer Shore Battalions further enlarged the wire network by setting up a battalion switchboard connecting in the shore companies and the Regimental Combat Team Headquarters over wire laid by the combat teams inland from the beach. Still later the Signal platoons of the Engineer Special Brigades laid wire to connect the shore battalions. They ran laterals between brigades where possible, and connected the brigades to Air Force dumps and to all dumps supervised by the brigades.

The biggest problem in wire communications was connecting the forces at the two beachheads. This was accomplished originally by radio link and later by laying spiral-4 cable.

Wire Communication on the Continent

During the assault on the beaches radio was the principal means of communication. The first cross-channel electrical communication was by VHF radio link. Teletype service was established by this means and cleared much urgent traffic. Facsimile transmissions were also made between the continent and England. By D plus 3 the British 21st Army Group had installed a submarine cable from England to the beach in the British sector. Later, after the capture of Cherbourg, two more such cables were connected in. Occasionally calls from First Army to England were routed over these circuits.

As our troops forced their way inland wire assumed a greater role in providing communications. During the period before the breakthrough much was learned about the consumption of wire. Initially stocks of field wire W-110 and assault wire W-130 were ample. It was found, however, that far larger replacement stocks would be required than had been planned. Wire supply remained a problem for the duration of the war in Europe, since in an operation of any magnitude about 3000 miles of wire was used each day.

Divisions used field wire and light assault wire almost exclusively. Light assault wire was used in forward areas for communications to O.P.'s where, because it was easy to handle, one man could efficiently and quietly lay the wire. Further back, in the battalion, regimental, and division headquarters areas, the sturdier field wire W-110 was used. This field wire was found to be exceptionally reliable.

Armored divisions had some difficulties with wire communications because of the large number of vehicles, especially vehicles with tracks. They soon learned to lay wire well off the road and, in areas where hostile artillery fire was not too great, well

f the ground. Some divisions suc-ssfully used long boom-like devices r thrusting wire high up in the anches of trees. This practice made ire recovery more difficult.

As had been expected, very little ire recovery was done at division evel because of their continuous apid movement. And far less was one at Corps and Army level than ad been hoped for. This was main- due to lack of time and personnel. poradically, emphasis was placed on ire and cable recovery, using signal ersonnel made available from other ssignments. The answer to the prob-em probably lies in providing wire ecovery units at Corps and Army evel and in the Communications one.

The quantities of wire used by rmored divisions was surprising. owards the end of the war their verage daily consumption was not uch less than that of an infantry ivision. During a fairly static situ-tion armored divisions would esta-lish complete wire networks to in-lude armored companies, platoons, nd O.P.'s. In at least one armored ivision all battalions were furnished mall switchboards. First use of this dditional equipment was made in the Ardennes in the winter of 1944-45. It was reported that wire was used to armored companies an average of 6 out of every 7 days.

In Normandy and in later operations Army and Corps troops used spiral-4 cable to great advantage. In Africa, much trouble had been experienced in trying to use this cable because of unqualified personnel, because the cable itself was poorly made, and because the terrain offered little protection. By the time of the invasion of the continent, the cable had been greatly improved, more experienced personnel were available, and the terrain of France, Belgium, and Germany offered adequate protection for spiral-4 if properly laid. The only real trouble experienced in the entire European operation was in icy or windy weather when the insulation would wear off if the cable were left installed along the branches of trees for a period of several weeks.

Various types of wire circuits were used in the operation including field wire, spiral-4, rapid pole line, British multi-airline, open wire lines, and commercial open wire and underground cable facilities. Rehabilitated commercial facilities were of greater value than it had been anticipated they would be. In most cases terminal equipment was damaged beyond repair. It was not until months later, in Aachen, Germany, that time was available to rehabilitate a large repeater station. Prior to this, most repeater stations were by-passed. Subsequently repeater stations which had been only slightly damaged were used within Germany.

Radio Communication on the Continent

While wire was the principal means of electrical communication on the continent, radio continued to play an important role. After the assault phase was over, radio link, except for cross-channel communications, could not be used for many weeks because of lack of equipment. In the phase subsequent to the assault radio communications were for the most part normal. Losses in low echelon radio equipment were high, and continued to be very high in the case of "walkie-talkie" sets used by infantrymen.

It was generally felt that the security of radio communications could be improved upon. This was especially true of amplitude modulated signals from stations which remained fixed

In the ruins of Aachen a large repeater station was rehabilitated.

for several days at a time. The double call sign method had been used in the United States during maneuvers. Division Signal officers complained that sufficient traffic could not be cleared by this method, and that the procedure was not secure. This had led to the adoption of the single call sign method before the invasion of Africa. This method reduced the calling and authentication period by more than half, permitted much more time for sending the actual message, and was more secure. But the greatly congested high frequency band would not permit regular changes in frequency assignments. The daily change of call signs combined with frequent moves of command posts gave a reasonable amount of security, particularly at Division level, where radio was used most.

Improvements in security and safety were also made by the remote control of transmitters. All operators would be located with their receivers and keys in a tent or van in a well protected place, or in the basement of a building. Cables or field wire were then laid for several hundred yards to the widely dispersed transmitters. This plan worked well, particularly at Army and Corps level where ample time was available to lay and pickup the cable. In divisions it was sometimes more difficult to use this system because of frequent moves. Here operators would frequently remove the necessary equipment from vehicles during any halt of 24 hours or more, particularly if the area was under considerable shell fire.

This radio security problem always exists, and it prevailed for the duration of the war. When considered as a whole, however, it was not serious. At higher levels where radio was less secure, only small quantities of the total traffic were sent by radio. At the lower levels where security was better because of frequent movement, the percentage of total traffic handled by radio was much higher.

By the first of July, 1944 sufficient radio link equipment was available so that each corps could have a team. Soon afterwards teams were available for some divisions. The number of radio link teams increased steadily until the end of the war. One of the most significant and forward steps in combat communications was the development of a successfully integrated system consisting of radio link, spiral-4 cable, and rehabilitated commercial facilities.

On the whole little trouble was experienced with radio link equipment. Most of the receivers had to be realigned at one time or another, some very frequently. Modifications were gradually made by the Army, and most of the trouble had been eliminated prior to the crossing of the Roer River in February 1945.

Communications for Air Support

Initially communications for air support of ground troops were not very satisfactory. During the assault no quick adequate means of obtaining close fighter-bomber support was available. This was especially true in the case of airborne troops. Elaborate plans had been made, which included the use of either fighter direction ships or headquarters ships as radio relay points. This procedure greatly delayed support and left ground troops uncertain as to whether the support would ever come. Later when First Army Headquarters was established on the continent and after fighter strips were constructed, communications and consequently the support received was greatly improved.

Perhaps the most significant development of the entire war with regard to air-ground communications, occurred during the breakthrough at St. Lo. Each armored battalion was furnished with a VHF radio, SCR-522, the type installed in fighter bombers. This set was installed in the tanks which were to lead the armored columns. These tanks were in communication with fighter-bombers immediately overhead as the advance took place. The speed and magnitude of the breakthrough at St. Lo, and the successful exploitation was due greatly to this close air-ground communications. It enabled the Air Force to maintain continuous close support over the columns and along their route of advance. During the first six days of the breakthrough over 400 missions in support of armored columns were flown. Vast numbers of enemy armored vehicles, motor transport, and personnel were destroyed on these missions. A German prisoner of war, who had served at length in the fighting against Russia and in other areas, described the combined air-ground attack as the most devastating he had ever witnessed. This air-ground communications method was used throughout the remainder of the war with the same successful results.

Tank-Infantry Communications

Tank-infantry communications were a problem during the entire operation on the continent. Numerous methods were tried to enable tanks to give close support to foot troops. Microphones and EE-8 telephones were placed on the rear of tanks. These were connected to the tank interphone system through holes drilled in the armor. This proved unsatisfactory because an infantry soldier could not keep pace with a tank in all situations where such communication is desired, and at the same time protect himself. The SCR-510, which would work on tank radio frequencies, was rigged so it could be carried on a soldier's back. These proved too heavy, and when the going got rough, the foot soldiers would often abandon them. Just before the beginning of the Ardennes Campaign a number of SCR-300, the pack infantry set, were installed in key tanks. This method provided suitable communications, but it had certain disadvantages. The installation had to be made in the turret of a tank, adding one more large item in an already overcrowded space. New radio equipment now being developed with artillery, tank, and infantry frequency bands overlapping will probably solve this problem.

Army Headquarters Communications

American troops moved across France into Belgium very rapidly. The large command headquarters of First Army could not keep up with this movement. A small advance group called TAC Headquarters was organized soon after the assault, and this group moved out ahead of the Main Headquarters. About thirty moves of TAC Headquarters were made from the breakthrough until the end of the war in Germany. Complete communications to all essential tactical units had to be installed at each location, and the same units had

Maj. Gen. Harry C. Ingles Span.

be tied into the Main Headquarters. This complicated the communications problem at the Army Headquarters level.

In the beachhead area telephone and teletype centrals were setup in tents. This usually took too much time. Level floors had to be installed. Extensive equipment consisting of from three to six telephone switchboard positions, six to eight teletype machines and a teletype switchboard had to be manhandled into position and connected up. Installing equipment in houses was tried. Much of the terminal equipment was too large and bulky to go through doors or windows. Also, too much time was still consumed in installing equipment.

Finally, and fortunately in time for the speedy operations following the breakthrough, the equipment was installed in large ten ton vans, and the mobile Signal Communications Centers came into being. These accompanied both TAC Headquarters and Main Headquarters on all moves from the breakthrough to the end of the war. When the situation became static, more permanent installations were made, but the vans were always held in readiness for a rapid movement of the echelon. Through the use of these mobile units, it was possible to make a rapid setup of Army Headquarters close behind Corps and Division Hadquarters, which was invariably desired by the Army Commander.

Radio Intelligence

The radio intelligence service of First Army Signal Troops was very satisfactory from the first. The system of operation used in Normandy was carried through until the end of the European campaign. Separate telephone, teletype, and radio nets were established for the Army and Corps Radio Intelligence Companies, and the Army Company was in a cross-channel net with Signal Intelligence Service, ETOUSA.

Each company also had direct communication to the G-2 of the headquarters served. In First Army the administration and technical direction of these companies was under the Army Signal Officer. Corps and Army G-2's requested the information they wanted direct from the companies.

The traffic analysis units of the R.I. Companies were very efficient. The members of these teams were some of the most intelligent men in the Army. Each company had a traffic analysis officer. Every morning he met with the Signal Intelligence Officer of the Army or Corps Staff and a representative of Army or Corps G-2 to receive instructions.

Wire across the Rhine. The Rhine was crossed with cable in seven places.

Photographic Service

The work of the assignment units of the Army photographic company was excellent. These units were attached on the basis of one for each corps and division. They were under the direct control of Corps and Division Signal Officers. Their overall activities were coordinated by the Army Photographic Officer. The Photographic Company Headquarters was located near the supply echelon of Army Headquarters. With it remained the two newsreel assignment units and the two identification units. They performed numerous missions as directed. Excellent coverage of the assault was made, and this service continued to distinguished itself until the fighting in Germany came to a close. There were more casualties and awards of decorations in the photographic company than in any other Signal Corps unit.

Signal Supply and Repair

The Army Signal repair company was located near the signal supply depot. First and second echelon repair was performed by the signal units themselves. Continued emphasis on this phase of signal repair kept the maintenance at a minimum. Third echelon repair was performed by division repair sections with assistance of teams from the repair company. Fourth echelon repair was done by the repair platoon of the Signal depot company.

Direct replacement to the using unit for any item needing third or higher echelon repairs was usually made. Initially teams from the Army repair company were attached to the Engineer special brigades and later to advance signal dumps and ordnance maintenance units. Installations in armored vehicles gave considerable trouble, and much credit goes to the IX Tactical Air Command for the manner in which they assisted the ground forces at all times. This was especially true in connection with the installation of Air Corps type radios in tanks, many of which the Air Force repair teams made for the ground forces.

From the first, Signal supply in the First Army was almost beyond reproach, especially in the light of the difficulties service troops had experienced in Africa and Sicily.

The unusually high consumption of field wire and spiral-4 cable and the high losses in such items as the SCR-536 radio, caused some serious resupply problems. But on the whole throughout the European Campaign of First Army, supplies of signal material were adequate.

EDITORIAL

ARMY DAY

According to an announcement by the Department of the Army, April 6, traditionally designated "Army Day," will this year feature "the National Security theme and the enormous responsibilities the Army faces in providing for such security—especially in such missions as occupational and military government tasks and keeping in the forefront of the march of technology." That means the Armed Forces must continue to have a system which will produce for tomorrow when needed, the Marshalls, the MacArthurs, the Clays, the Eisenhowers, and the Groves, to name only products of the Army since this is an Army Day editorial. Most of those in Washington who have the facts about the international situation seem agreed that we have troublesome years ahead.

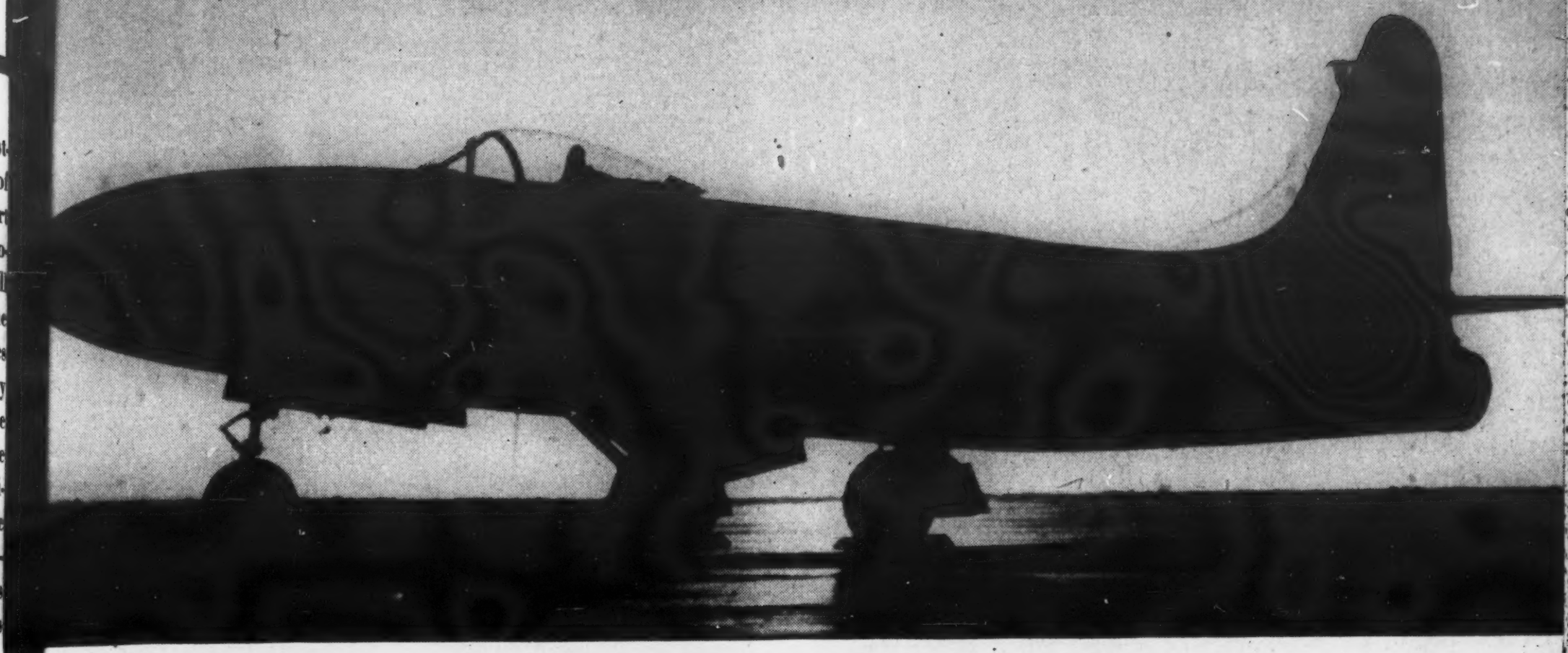
General Eisenhower, in his final official report, emphasized that "military leadership is of more critical importance than ever before" and that "upper levels of command require the utmost in ability, training and skill." He said further that our position 5, 10 or 15 years hence is being determined now.

Most of us after we have given it careful thought, realize that there must be in the services, competent men available for these intricate jobs. That means, as we said in an editorial in September 1946, that the armed services must continue to attract a fair share of America's future "men of merit." This is one of the reasons General Eisenhower said that we should make professional military service more attractive, particularly in the officers corps.

Current reports indicate that some corrective action is needed now to accomplish that. It has been alarming to learn that there is now a shortage of qualified candidates applying for entrance to West Point and Annapolis. A shortage in these academies today means less likelihood of men with the necessary qualifications being available when the United States desperately needs them tomorrow. A careful study of the reasons for this indicates there are two major causes. One of these—the rising wave of attacks against the military, especially officers, which Major General Manton S. Eddy recently described as "sinister." Speaking before the Association of Military Colleges he declared that these attacks are so persistent that he believes they can poison the minds of our people against one of their most stalwart guardians of freedom—the American military profession. He implied that the purpose might well be to make the military profession—and he meant the Army, the Navy and the Air Forces when he used that term—so unpopular that it may well become inferior. Already, he pointed out, the Army is being hurt by this campaign as there are numerous vacancies at West Point because sufficient young Americans capable of meeting the high standards did not, in the last year, seek appointments. If we are to have military leaders capable of planning to keep us strong and thus reasonably safe from attack and to lead us to victory again, if we must fight another war, these attacks by some sections of the press and elsewhere, ought to be examined. A case in point is the headlining in some sections of the press of Army speculation in grain, implying that Army officers were involved when it later developed that professional officers were not meant.

It seems more than likely that one of the principal reasons that a considerable proportion of those offered commissions in the regular services did not accept them is the inadequacy of the present service pay. It must account too for resignations from younger, more able officers as well as retirement of many who have reached high rank. Secretary Forrestal has recognized the urgent need for a completely new pay scale to replace the one that has been in effect practically without change, in the higher commissioned grades especially, since 1908—over forty years. And think how much the cost of living has risen since that day! The secretary's board of service officials has completed a study and a specially selected board of leaders from industry is now reviewing those findings to bring them into line with pay in corresponding positions in industry. It must be recognized that success in the services will bring substantial rewards, just as it does in American business and professional life. Perhaps it is more essential to our specialties of communications and photography that we attract a reasonable proportion of the best brains of the country into them than many others. It is to be hoped that the Congress does not ignore the very critical need for corrective action without further delay.

PHOTOS *Contest Entries*



P-80 at sunrise by: William B. Owen, M/Sgt. Camera: Kodak Reflex, lens—Kodak Anastigmat f 3.5, 80 mm. film—Ansco Supreme, Shutter speed—1/25 Exposure—F 11, Filter—Yellow.

Major General Russell B. Reynolds, Chief of Special Services, Department of the Army, sponsor of the world-wide Army and Air Force Photography Contest, is shown holding the grand prize trophy and prize after the judging February 18, 1948. The grand prize photograph hangs on the wall.

Nipa shacks near Lingayen Beach, Luzon, P. I. Taken by Lt. Franz Ucko. Camera: Rollaflex, F. 11, 1/100, K Filter, Super XX film.

"STUDY IN DIGNITY"—Filipino Grandmother by Lt. Franz second prize winner, Category C, Foreign Countries and P No photo data.

"LEST WE FORGET"—Study of a Filipino child after the Luzon campaign by Lt. Franz Ucko, third prize winner, Category D, (no data).

OPPOSITE PAGE

No. 1—"ST. JOHN'S BRIDGE, PORTLAND, OREGON" b Robert C. Clemens. Data: 4x5 Speed Graphic equipped wit Optar Lens. Film: Infra red.

No. 2—Legislative Building and Manila City Hall after Ba Manila by Lt. Franz Ucko. Camera: Speed Graphic 4x5, F 16 G Filter, Super XX Film.

No, 3—By Captain Howard A. Thornbill (no photo data

No. 4—"CHINESE SCHOOL CHILDREN DANCING WITH TEACHER" by T/4 James A. Hirtz, first prize winner in Ca C, "Foreign Countries and People," (no photo data).

No. 5—"ALASKAN CRIBBAGE BOARD" by 1st Lt. Da Burkett, third prize winner, (no photo data).

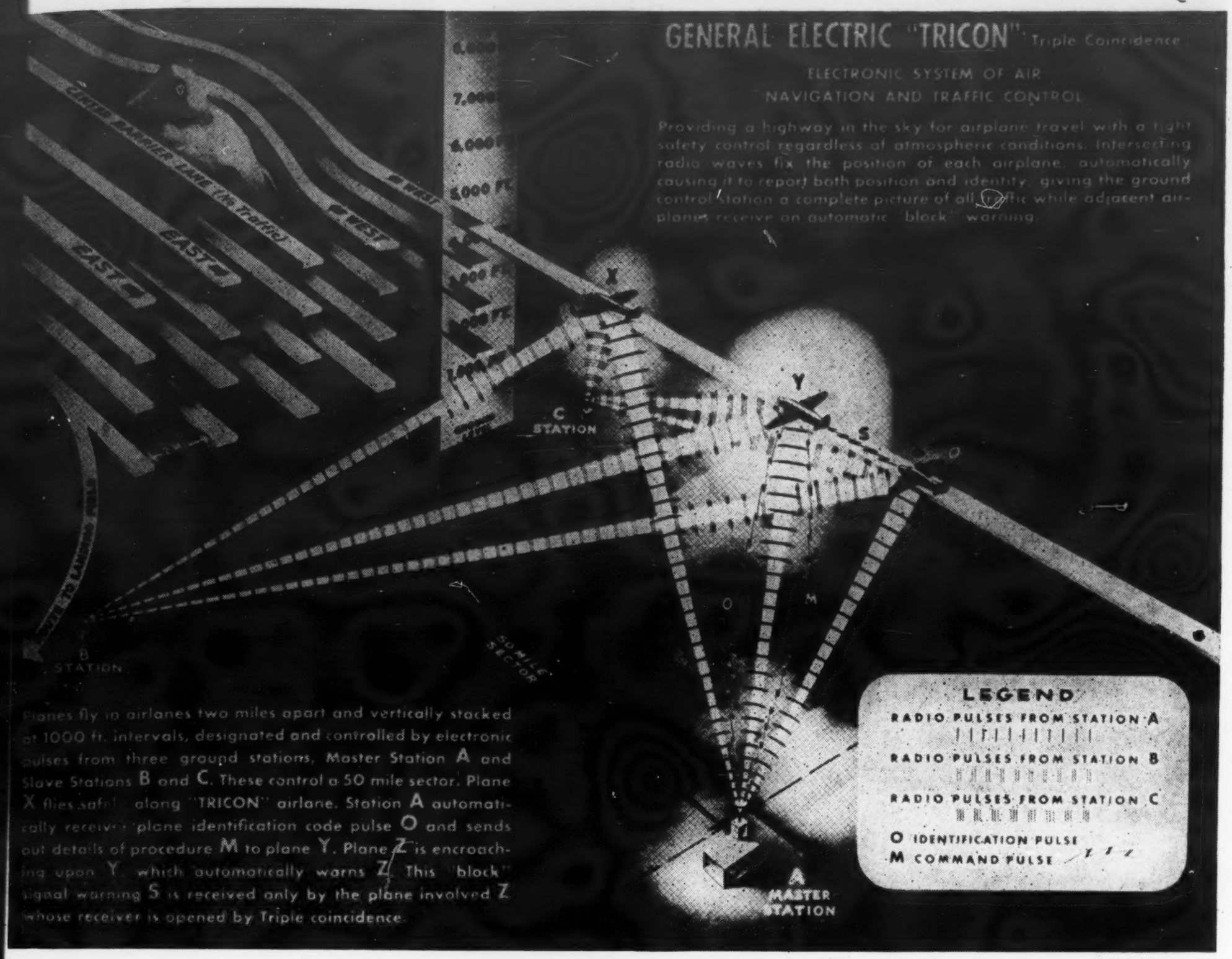
No. 6—"POWER" by Lt. W. C. Kreps, (no photo data

By T/Sgt. Erwin K. Freytag, Canal Zone. Data: Taken with Folmer Graphic Miniature Camera EK Super XX Film, with a Wratten "G" Filter at 1/100 second at f.16.

"STUDY OF A SOLDIER" by Staff Sergeant John M. Pavelke, in Wiesbaden, Germany, second prize winner, Category A, (no photo data).

"SOUR PUSS" by Staff Sergeant Fred X. Moore, first prize winner in Category D, (no photo data).

By Lt. Col. Wm. B. Bunker. Leica Summitar, f 5.6 c 1/10, Yello filter, Pancromatic X.


GENERAL ELECTRIC "TRICON" Triple Coincidence
ELECTRONIC SYSTEM OF AIR
NAVIGATION AND TRAFFIC CONTROL
Providing a highway in the sky for airplane travel with a high safety control regardless of atmospheric conditions. Intersecting radio waves fix the position of each airplane, automatically causing it to report both position and identity, giving the ground control station a complete picture of all traffic while adjacent airplanes receive an automatic "block" warning.
CENTER BARRIER LINE TO TRAFFIC
WEST
EAST
WEST
EAST
5,000 FT.
C STATION
B STATION
A MASTER STATION
50 MILE SECTOR
X
Y
Z
S
O
M
LEGEND
RADIO PULSES FROM STATION A
RADIO PULSES FROM STATION B
RADIO PULSES FROM STATION C
O IDENTIFICATION PULSE
M COMMAND PULSE
Planes fly in airlanes two miles apart and vertically stacked at 1000 ft. intervals, designated and controlled by electronic pulses from three groupd stations, Master Station A and Slave Stations B and C. These control a 50 mile sector. Plane X flies safely along "TRICON" airlane. Station A automatically receives plane identification code pulse O and sends out details of procedure M to plane Y. Plane Z is encroaching upon Y which automatically warns Z. This "block" signal warning S is received only by the plane involved Z whose receiver is opened by Triple coincidence.

TRICON

By Homer R. Oldfield, Jr.

The future of the air transport industry depends in part on the development of improved air navigation and traffic control facilities which can meet the requirements of an expanding air age. Inasmuch as these same facilities are required for non-tactical military operations, it is evident that a solution to the problem will not only strengthen the position of the nation's commercial air carriers but will also be of great benefit to the U. S. military air arms.

The problem to be solved is not simple, as it is necessary to increase the safety of the airways and, at the same time, greatly improve their traffic handling efficiency. It is perhaps not immediately apparent that, under conditions of poor visibility, any steps which are taken to speed up the flow of traffic, decrease cancellations, or eliminate diverted flights, will act directly to decrease the margin of safety. This must be so, as the increase in traffic handling capacity can be effected only by increasing the traffic density and, consequently, decreasing the safety interval between aircraft. Thus, two mutually conflicting factors must be considered, and it is necessary to make drastic improvements in both.

The problem is aggravated by other factors which make the solution even more difficult. The number of aircraft which must be accommodated by the air traffic control system is increasing steadily, as is the speed of these aircraft. Both factors tend to increase the traffic density, even though the rate of traffic flow remains at its present unsatisfactory level. A further complication is the fact that the airways must be made available to a variety of users, all with requirements which are at least partially conflicting. Finally, the global nature of air transportation requires world wide adoption and presents a unique technical problem in surmounting language barriers.

Radar Problems

Wartime applications of airborne radar were so spectacular that the American public expected a rapid conversion to the problems of peacetime flying. This has emphatically not been the case, mainly because of three factors which were almost universally overlooked. First, and probably most important, airborne radar equipment is far from cheap. Although it is extremely valuable and

A Philosophy of Air Navigation and Traffic Control

performs functions which cannot be duplicated in any competing equipment, it can be installed economically only in the larger passenger planes. Second, the problem of efficient traffic control can be solved only by a system which provides a continuous interchange of information between ground and air personnel, and such a system is not readily evolved from standard radar techniques. Third, radar devices are not easily adapted to automatic flight although they are unexcelled for the purpose of monitoring such flight.

The requirements for an ideal air navigation and traffic control system are too numerous and complex to be considered in detail in this article, but is possible to outline the more important characteristics. First and foremost is the need for a highly accurate navigation device which provides each pilot with a continuous, easily interpreted indication of his position along the airway. Coupled with this must be a means of indicating on the ground the position and identity of all aircraft flying the airway, plus equipment to allow the ground controllers to transmit commands at will to selected aircraft. The airway itself should contain sufficient tracks, or highways, to allow high peak traffic densities to be handled with safety and to allow diversion of traffic under emergency conditions. On top of all this is an over riding safety requirement which dictates that the pilot must have continuous information concerning the presence of other aircraft in his vicinity.

Traffic Control Concepts

There are two distinct schools of thought concerning the method by which the objectives outlined above can be attained. The first visualizes equipment which will provide the aircraft with position information in the form of range and angular coordinates which, by means of a computer in the aircraft, can be used to establish tracks between any two desired points. This provides high flexibility but greatly complicates the traffic control problem. The second school of thought visualizes ground equipment which will establish fixed tracks in space much as automobile highways are established on the ground. While this method is not so flexible, it removes the necessity for computation within the aircraft and greatly reduces the chances for error. It also simplifies the problem of traffic control. This latter method would appear to be superior if one can solve the technical problems of establishing sufficient tracks to provide high traffic handling capacity and if these tracks can be made sufficiently flexible to handle traffic diversions.

The Tricon system was conceived in an effort to provide the advantages of the second school of thought while, at the same time, eliminating the disadvantages.

Table 1 gives, in summary form, a list of the outstanding advantages which appear to be inherent to the Tricon system.

General Description

The artist's conception at the top of the first page shows a possible section of a Tricon airway. It consists of a series of parallel tracks, or lanes, separated by perhaps two miles laterally and 1000 feet vertically. The tracks are established by pulse signals emanating from three ground transmitters which are synchronized in a particular manner to be discussed later. It is noted that the tracks can be either straight or curved and, hence, can be tailored to fit the geometry of the region where the airway is located. For instance, holding or delay paths can be established, tracks can be curved around mountains or other obstacles, and airport traffic patterns can be set up.

Closely integrated with the navigation system described above are traffic control facilities of a unique nature. Each aircraft automatically reports its identity, position, and altitude to the ground where the information is presented automatically or is fed into a computer for traffic calculations. Ground control personnel, in turn, can send commands to selected aircraft merely by pushing buttons on a small keyboard. These commands are automatically acknowledged and presented on the instrument panel of the aircraft for

Table 1. Principal advantages of the Tricon system of air navigation and traffic control.

NAVIGATION	TRAFFIC CONTROL	SAFETY	GENERAL
1. Establishes multiple airlanes which can be either straight or curved.	1. Presents complete picture of traffic flow in a form convenient for use by ground controllers.	1. Precise navigation and traffic control information allows proper spacing of aircraft to avoid dangerous conditions.	1. System requires only 6 megacycles band width for coverage of entire U. S., as contrasted to several hundred megacycles for previously conceived systems.
2. Allows great flexibility in the number of tracks, track separation, and track curvature.	2. Provides "push button" flow of command data from ground to any selected aircraft.	2. Block signal system automatically warns of aircraft which are approaching an unsafe separation.	2. No radical improvements of existing electronic techniques are required, but merely the marriage of existing techniques.
3. Establishes tracks with extreme accuracy; ± 500 feet transverse to track and ± ¼ mile along the track.	3. Allows the establishment of precise traffic patterns which guide aircraft directly into the beam of the GCA or ILS landing system.	3. Block signal system allows pilot to investigate occupancy of adjacent blocks.	3. Push button command system eliminates language barriers.
4. Presents navigation information to the pilot in a form which is easily interpreted and which can be fed directly to an automatic pilot.	4. Furnishes information in a form which can be fed directly into a traffic control computer.	4. Navigation tracks can be curved around dangerous obstacles such as mountains and tall buildings.	4. Airborne equipment is relatively simple and lightweight.
		5. Presence of obstacles in general vicinity of tracks is indicated automatically to the pilot.	
		6. Pilot has no adjustments to make, hence can do nothing fo disturb the accuracy of the system.	
		7. Simple presentation minimizes possibility of wrong interpretation.	

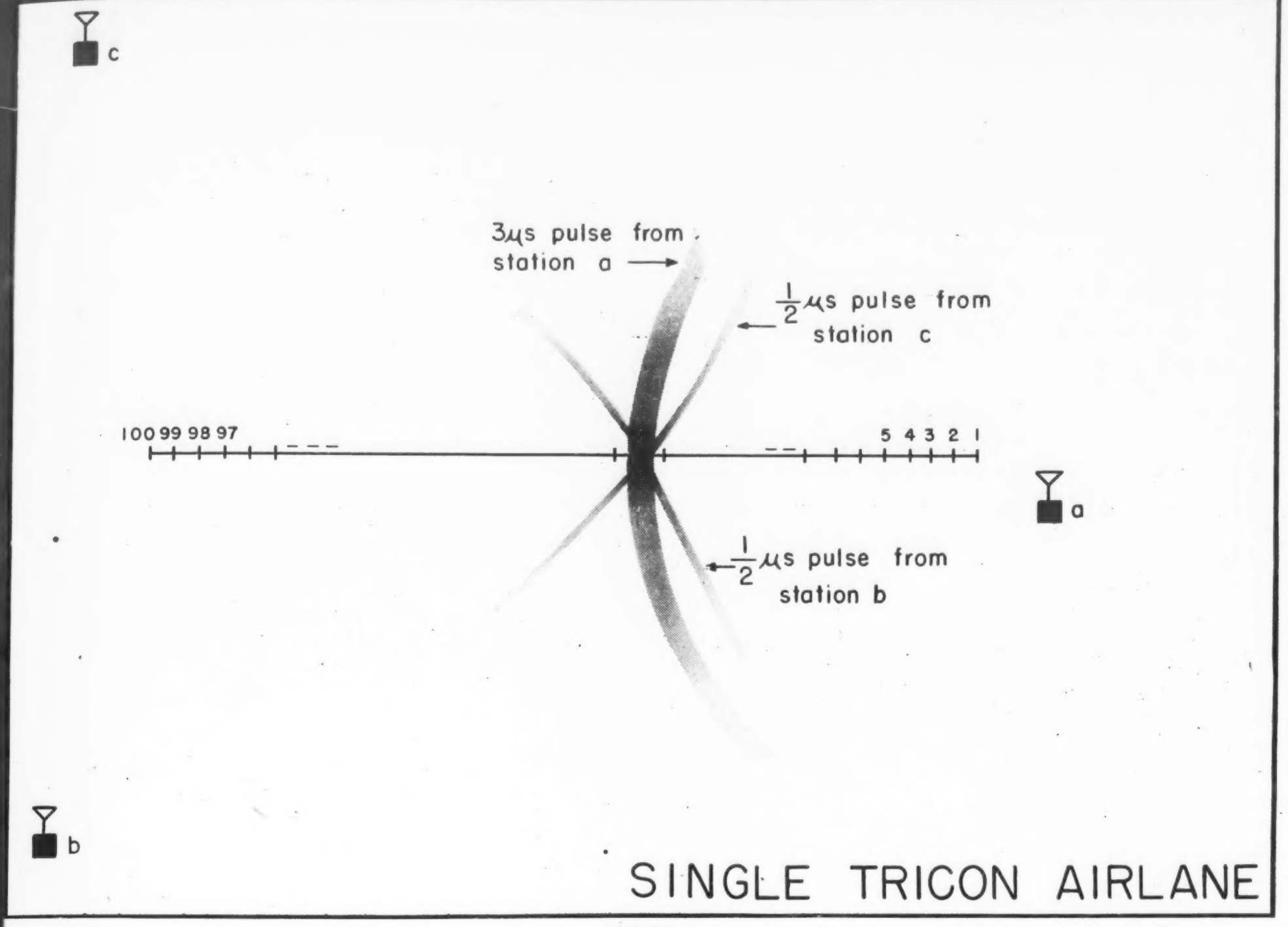


Figure 1.

which the command is intended. The complete interchange of information takes only a few seconds and does not require the use of any voice facilities.

A "block signal" system is provided which warns each pilot of the presence of other aircraft in his immediate vicinity. Distinctive signals indicate the presence of aircraft to the front or rear and can also be used by the pilot to determine the presence of aircraft in blocks to either side, or above or below. Thus the pilot is not dependent on any ground control agency as far as safety is concerned.

Principles of Operation

Figure 1 is a plan view of one track of a Tricon airway. The track is fifty miles long and is made up of 100 discrete but overlapping points, each point covering a distance of one-half mile along the track. The track is two miles wide, but deviation from the center of the track is determined to within 500 feet.

The track is established by means of pulses radiated from three ground transmitters, a, b, and c. Station a is the "master," and sends out 3 microsecond pulses at a regular repetition rate of perhaps 3000 pps. Stations b and c are "slaved" to station a, and send out ½ microsecond pulses which are delayed, *pulse by pulse*, a predetermined amount. The amount of delay is just sufficient to cause "triple coincidences" to occur at desired points along the track. (A trip coincidence occurs when all three pulses arrive simultaneously at a given point.) The track is established by causing triple coincidences to occur at different points in turn, each point being separated by 1/3000 second (333 microseconds). Point 1 is established first, then point 2, and so on until the entire 100 points have been defined.

Now suppose that we have a receiver which is sensitive to triple coincidences, and a counter which is sensitive to 3 microsecond pulses. At the beginning of the timing cycle, station a sends out a distinctive signal which, in effect, says "start counting." Triple coincidences are then established at the various points along the track starting with the point 1; each coincidence being associated with a 3 microsecond pulse from station a. Our counter counts each of these 3 microsecond pulses until a triple coincidence occurs, at which time the counter stops. If we are at point 10 (5 miles along track) there will be ten 3 microsecond pulses counted, up to and including triple coincidence. If we are at point 100, there will be 100 counts, and so on. Figure 1 shows a triple coincidence occurring at point 30, 15 miles along the track. If we were located at that point we would count 30 pulses between the initial timing marker and the time of triple coincidence. Thus, by counting pulses from a reference marker until the time of triple coincidence it is possible to establish distance along the track to within approximately one-half mile.

Lateral deviation from the center of the track is obtained by measuring the elapsed time between the arrival of the one-half microsecond pulses from slave stations b and c. If the pulse from c arrives slightly before the pulse from b, the aircraft is closer to c and, hence, is to the right of the track. Short pulses are used for this purpose to insure that the lateral accuracy is at least +500 feet at all points along the track. In order to broaden the lateral coverage area, the triple coincidence is arti-

ficially widened by use of a 10 microsecond gate associated with one of the two slave pulses. This enables a triple coincidence to be received anywhere along the track within one mile from the center.

The pulses from the three stations can be unscrambled in the aircraft receiver by either of two methods. The most obvious is to employ three separate frequencies and to use three aircraft receivers. This method, however, is prodigal of equipment and spectrum bandwidth. A more practical method appears to be the use of pulse length discriminators combined with "delayed" coincidences which allow all three stations to transmit on the same frequency.

Figure 2 illustrates the extension of the technique discussed above to form a complete airway section of five lanes. They are formed by establishing triple coincidences along each lane in turn, in the sequence indicated by the numbers from 1 to 500. It is noted that lanes A and B are made up of triple coincidences which proceed from right to left in time, and that lanes C and D are made up of triple coincidences which move from left to right. This arrangement is used to establish directional traffic lanes in accordance with the "drive to the right" convention. The barrier lane, X, is just what the name implies. It will normally be used to separate the left and right traffic lanes, although it may carry traffic in emergencies.

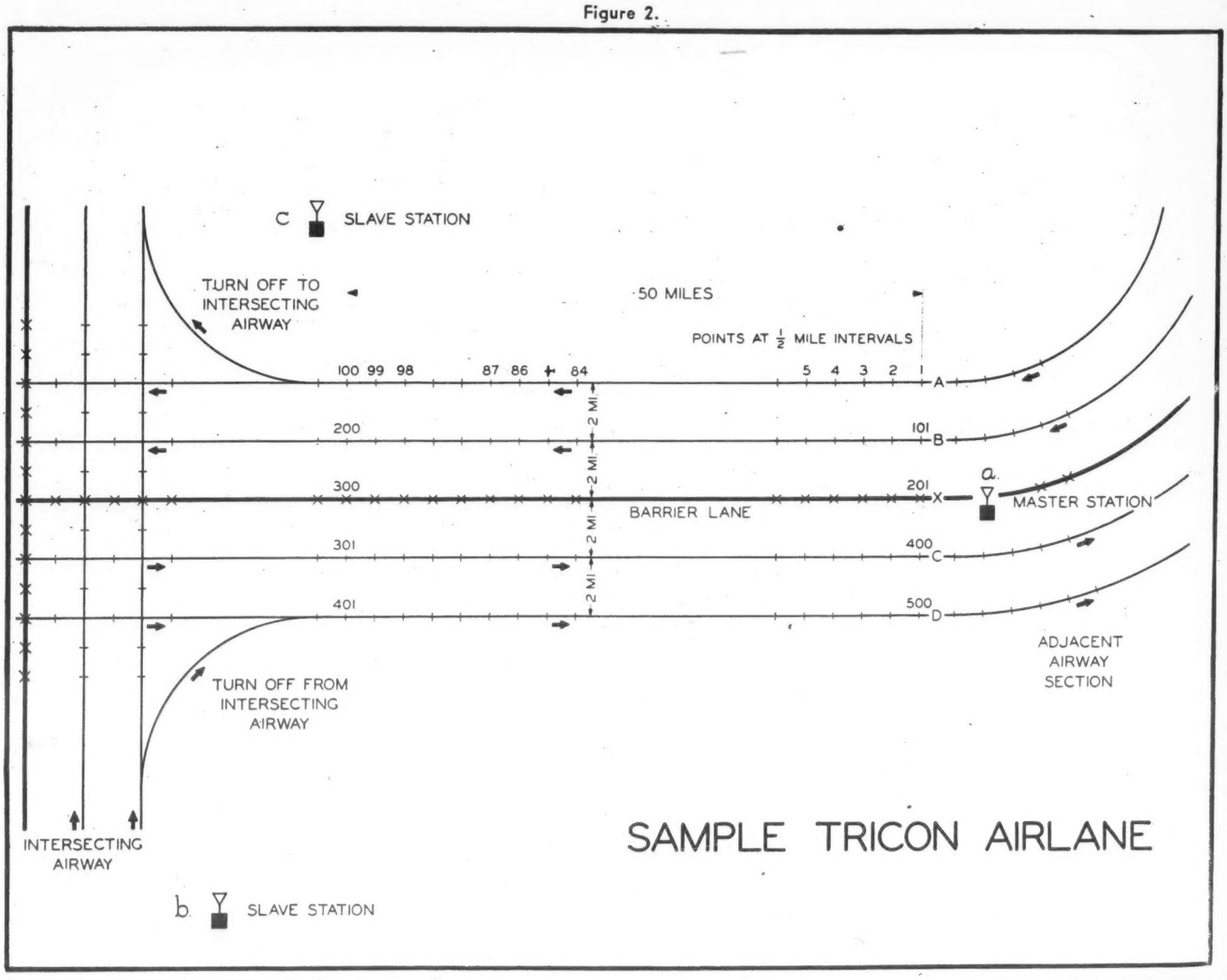
Traffic control information is sent from air to ground *immediately* after receipts of a triple coincidence. This is accomplished by an airborne transmitter which, on a separate frequency channel, transmits a signal which is altitude and identity coded. This signal, received on the ground, is automatically associated with the triple coincidence during which the transmission was initiated and, consequently, is associated with a particular point along the airway.

At the time of triple coincidence a receiver is sensitized in the aircraft on the same frequency as the traffic control transmitter. The receiver stays on for a predetermined time and then shuts off automatically. During this time, messages consisting of coded pulses can be transmitted from the ground. They will obviously be received only by the aircraft which has just received the triple coincidence and, hence, are strictly private communications.

The "block signal" warning feature is inherent to the transmitter-receiver combination described above and requires no additional equipment. It is evident that an aircraft, the receiver of which is energized by a triple coincidence, will hear transmission from those aircraft in the immediate vicinity whose transmitters are actuated at approximately the same time, and will not hear transmissions from aircraft separated further than an arbitrary block distance. (Transmissions from the latter aircraft will occur either before the receiver is energized or after it has turned itself off.) It is even possible, by proper timing, to provide one type of indication for overtaking aircraft and another for aircraft which are being overtaken.

The Tricon system utilizes the principles of time sharing to an unusual degree. Each five lane airway, involving an area of five hundred square miles, is established (in approximately one-sixth of a second)

Figure 2.



by triple coincidences which are separated in time by about 330 microseconds. Each triple coincidence defines a new point in space and, associated with each point, is a short time interval during which traffic control information is passed back and forth. The time sharing principle is carried even further by using the same slave stations for adjacent airway sections. During the first one-sixth second the first airway is established, during the next one-sixth second the second airway is established, and so on for five airways in turn. Thus a complete three-hundred mile airway is established in one second. This procedure is particularly advantageous in that it allows the use of a single navigation frequency for the entire three-hundred miles.

Presentation

The primary function of Tricon, or of any other air navigation and traffic control system is to present position and command information to the pilot in such form that it can be utilized with a minimum of mental interpretation. It appears, for instance, that the most effective method of presenting lateral deviation from the center of the track is by means of a left-right meter which is centered when the aircraft is on course. Distance along the course (or, alternatively, distance to go) can best be indicated by an odometer or by the combination of an odometer and a circular dial with pointer. The former has been chosen for purposes of illustration. The navigation information is completed by means of: A single odometer which indicates the airway section, an odometer which gives vertical (or laminar) position, and a series of lights which indicate the track being flown.

Figure 3 illustrates one possible choice of indicating instrument. It is seen that navigation information is presented in a straightforward manner which requires no interpretation. The track lights are arranged in such a fashion that they represent directly the tracks as they are laid out on the ground. (See figure 2). For instance, in the illustration, the pilot knows immediately that he is on the outside track without the need to remember a track number or letter. Below the track lights is the odometer which gives distance along the track and the airway indicator which identifies the fifty-mile airway section. Above the track lights is the L-R meter which gives lateral deviation. Below and to the side is the vertical indicator which is referred to less often.

At the bottom of the instrument

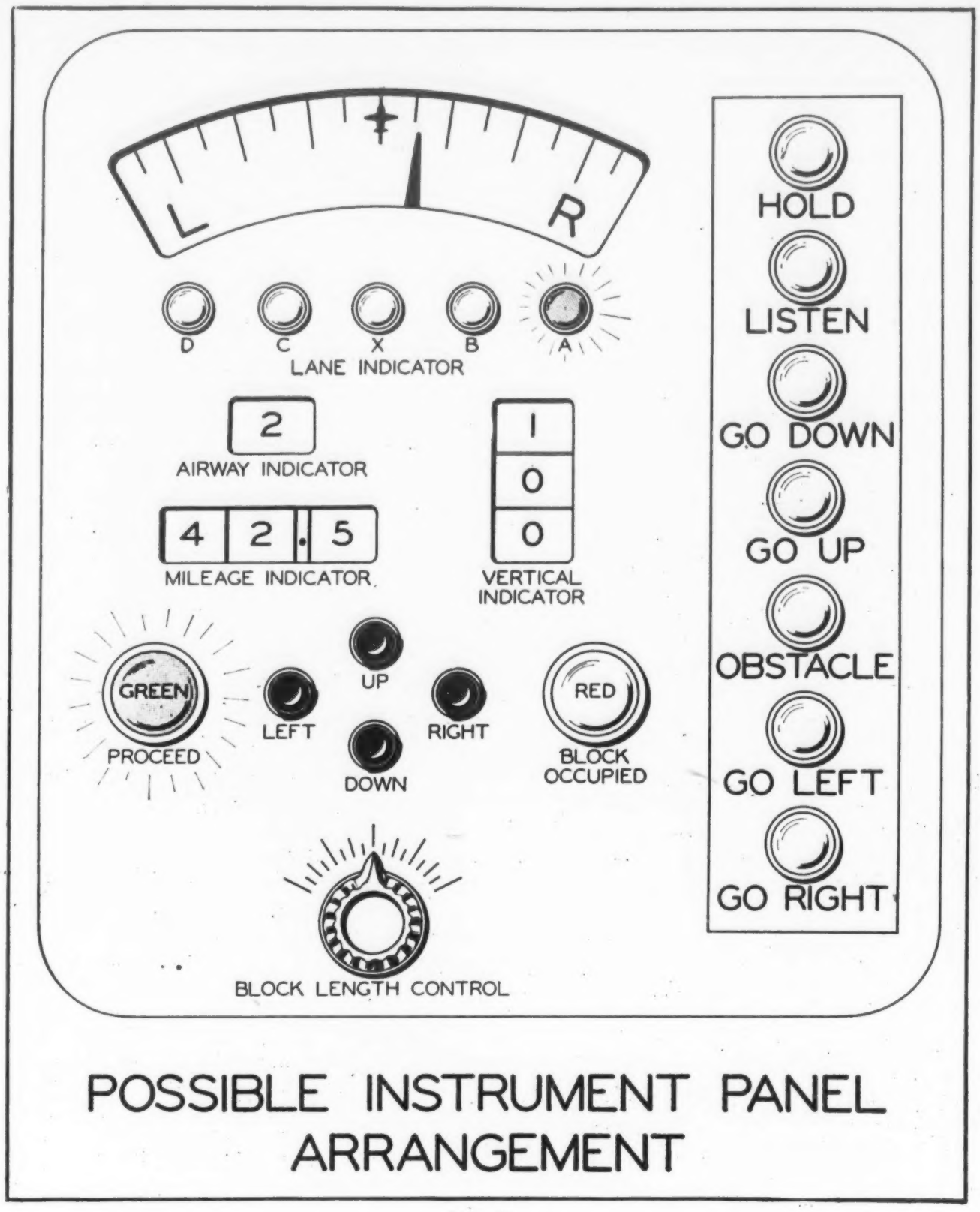


Fig. 3

panel is the "block" equipment. Four push-buttons enable the pilot to examine the occupancy of blocks to the right, left, up, or down. The Tricon system can be so arranged if desired, that the act of pushing the button also requests permission for the aircraft to move into the block being challenged. Under this method of operation, the block light will be "red" if the block is occupied or if it has been assigned to another aircraft. The red light must go out and the green light must come on to indicate a safe condition.

There is another extremely valuable function performed by the block indicator. During normal conditions the green light will be on. If the red light comes on and glows steadily it indicates that another aircraft is being overtaken at the same altitude and on the same track; hence the pilot must slow down or change track (or altitude). If the red light blinks at regular intervals it indicates that an aircraft is overtaking from the rear. It is probable that one would desire to have these warnings accompanied by distinctive sounds in the pilot's headphones.

The block knob shown in the illustration is used to control the length of the warning block. This knob would probably be non-existent in practice, as one would establish the block lengths at one or two fixed values. Otherwise the possibility would exist of the pilot hitting the knob by mistake and being unaware of the change. It has been included in the illustration mainly to indicate that the block length does not depend on ground station separation or any other arbitrary system parameter. It can be varied without changing ground or airborne equipment as aircraft speeds or operating conditions may dictate.

The remainder of the instrument panel is self-explanatory. Lights are associated with definite commands which can be sent up from the ground as desired by the controllers. Needless to say, the particular commands shown in the picture are for

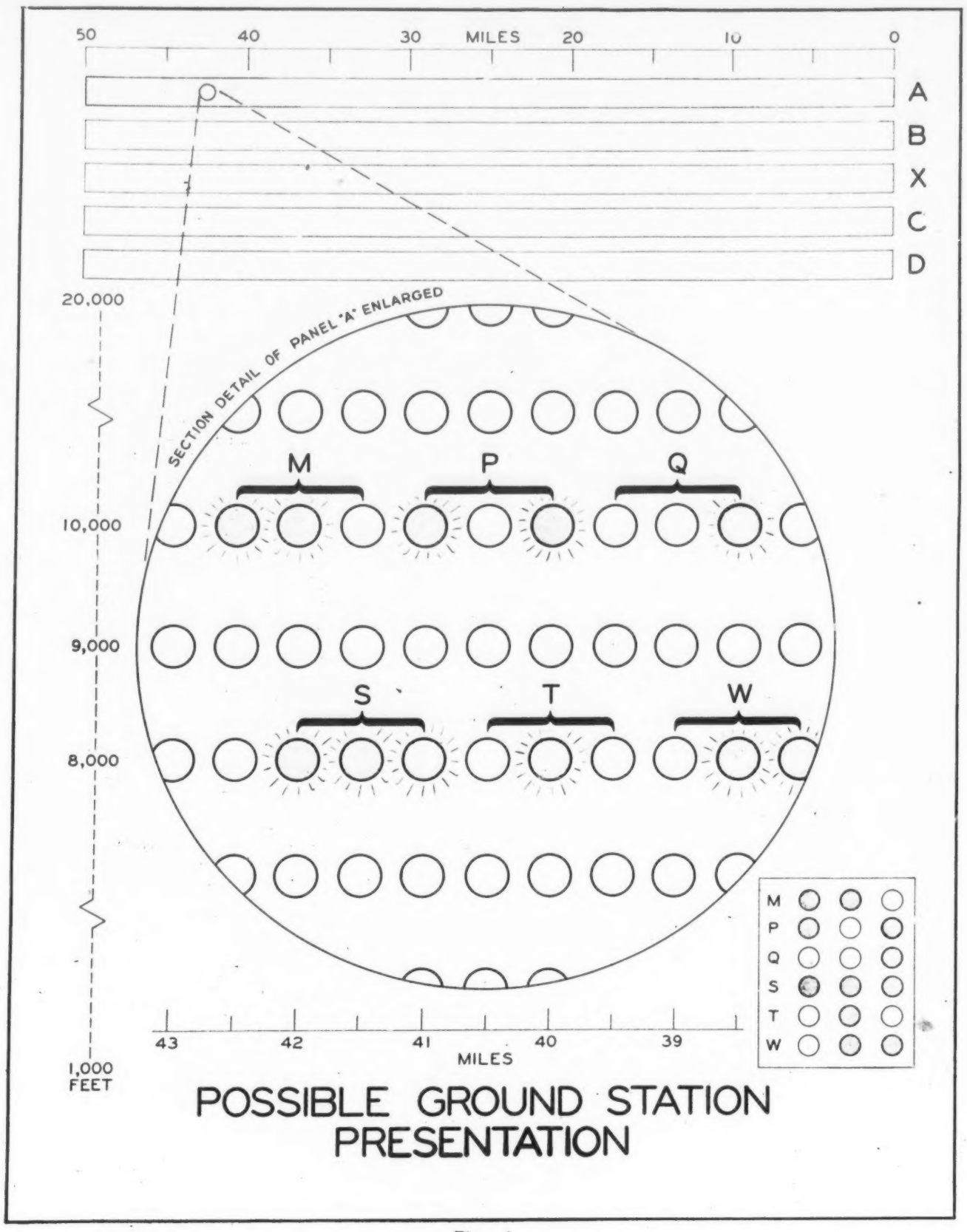


Fig. 4.

illustration only. The command lights will be duplicated (or will be double lights) and might glow faintly to indicate the absence of a message. They would intensify, or blink in some distinctive manner, to show receipt of a command. The command will be acknowledged automatically as soon as this happens. Not shown in the illustration, but capable of incorporation if desired, are push-buttons which allow the pilot to send certain elementary communications to the ground.

Presentation of Data on Ground

The exact method of presenting data to aircraft controllers can best be determined by those who have the job of controlling air traffic. It is probably safe to say, however, that the method must be automatic, and must present the following information in convenient form:

1. Aircraft identification (or flight number).
2. Aircraft plan position and altitude.
3. Aircraft course (or flight direction).
4. Scheduling information (minutes behind or ahead of schedule, or similar information in terms of desired and actual ground speed, expected and desired arrival time, etc.)

The factors listed above are probably not the only ones required, but they are obviously basic to any effective form of control. The first three as listed are obtained directly and automatically from the Tricon responses received from the various aircraft on the airway. The last piece of information can be obtained from any navigation system by a process of manual or automatic computation on the ground. As this information is essentially a derivative of the positional information furnished by the navigation system, its usefulness is directly proportional to the accuracy of that system and the speed with which changes in information are indicated. We will not discuss scheduling information further at this point except to note that the information received from a Tricon airway is highly accurate and changes at a regular and rapid rate. Thus it is particularly suited to whatever manual or automatic computations one desires to make. Under such conditions, the problem of deriving scheduling information and presenting it in a convenient form appears to be relatively simple.

Referring again to the first three pieces of information, the choice of how much information is presented and how that presentation is made will probably be based on economic considerations as well as upon operational convenience. With this in mind we will discuss briefly two presentation methods which appear to be both economical and easy to interpret.

The most obvious and direct method, and one capable of high accuracy, is to use a number of small neon lights mounted on a series of horizontal panels. As indicated in figure 4, there might be one panel for each of the five lanes, which each of the panels being divided into several altitude levels. An obvious variation would be to have one panel for each altitude level, with each panel showing all lanes. A third variation, possible if only a few altitude levels are required, would consist of one panel showing all tracks, with altitude zones indicated by different colored lights. For instance, we might have the following: Red, 0 to 1500 feet; white, 1500 to 5,000 feet; amber, 5000 to 10,000 feet; and green, 10,00 feet and above. The exact system used might vary with airport capacity, and it is immediately obvious that the neon light system would lend itself very nicely to such variation.

Figure 4 indicates the particular method of displaying each lane on a single panel, with a row of lights at each altitude. The magnified portion of the picture shows one possible method of coding aircraft responses to show identity. Other methods are under consideration, and it is probable that the ultimate decision will be made by operational personnel. The important thing to note is that identity can be shown, and that sufficient code combinations appear available to assign each scheduled aircraft a permanent identity number.

It is evident that aircraft altitude is shown by the particular row of lights in which the aircraft identification appears. The position of the aircraft along the airway is shown by the first glowing light. As lights are spaced at one-half mile intervals,

and as the distance along the track is accurate to one-half mile, the aircraft position is therefore defined to within one-quarter mile. This may be more accurate than one desires for normal purposes, but would apppear extremely desirable for terminal area use. In passing, it is noted that the lights themselves can assist in establishing a convenient scale for reading exact positional information from the status board. For instance, lights at ten-mile intervals might be bright, those at five-mile intervals somewhat less brilliant, and all others of normal intensity.

Another method of presentation would involve applying the Tricon responses to the horizontal sweep of a cathode ray tube. It appears rather simple to paint a picture of the entire airway in this fashion—presumably, one picture for each altitude zone required. This method is not quite so flexible as the neon light method in certain respects, but has the following attractive features:

1. The oscilloscope picture could be projected on a screen and there combined with the picture projected by a surveillance radar. If different colors were used for each it would be easy to spot any unequipped aircraft on or near the airway. (A projection system could also be worked out in conjunction with the neon light method, but probably not so simply.)

2. It would be convenient to assign certain sectors to individual controllers, and to furnish each with an expanded indication of his portion of the airway. This indication would be directly in front of the controller, and would be very convenient for control functions.

Control Features

There is little point in establishing an elaborate control station if facilities are not available for effecting that control. These are provided in TRICON by utilizing the time between aircraft triple coincidences to send commands to the particular aircraft which one desires to control. The mechanics of this are straightforward as far as the controller is concerned. He need only dial a number corresponding to the aircraft position and punch a key denoting the desired command. The command, pulse coded, is sent automatically at the proper point in the triple coincidence sequence so that only the desired aircraft receives the command. This aircraft automatically acknowledges the command (when the light on the pilot's indicator is lit), thus giving the ground controller positive indication that the command has been received.

It is important to realize that the communication procedure referred to above takes place without any increase in radio spectrum bandwidth. Messages in the form of additional coded pulses are alternated with annunciator pulses and are given what one might term a free ride to the target. It should also be noted that the transmission is altitude coded so that, if two aircraft are at identical positions but separated in altitude, only the designated aircraft will receive the transmission.

There is a very significant application, not evident at first glance, which can be made in connection with the command system. Once agreed that it is possible to send commands to a particular point in space, and to send similar or different commands to all other points once every second (the complete airway cycle), it is evident that these commands can be pre-set so as to go out automatically and continuously to these points. Thus, certain altitudes can be tagged *Restricted, Keep Out* at certain points, recurrent commands can be tacked up at the proper points in space, such as *You Are Now Entering the New York Approach Zone,* or *Next Right Turn to Minneapolis,* or *Obstacle Ahead.*

This permanent message facility can be extended to establish a three dimensional path in space, useful during the let down which precedes the actual landing operation. The glide path so formed will be crude, but sufficiently accurate for the purpose. For instance, consider an aircraft on the outside lane traveling at 5,000 feet. When it reaches the appropriate point along the airway it will receive a message stating *Descend.* As the aircraft proceeds along the track it will receive messages stating either *High* or *Low* depending on whether it is descending too slow or too fast. This type of information recurs from point to point and enables the aircraft to enter the ILS or GCA at the proper plan position, heading, altitude, and even approximately correct glide path.

It is obvious at this point to the critical reader that there will be a maximum number of commands, dependent on allowable bandwidth, which one can squeeze into the time increment occupied by one aircraft. Just how many might be allowed for each purpose is an operational decision.

Terminal Area Problem

It has been stated that the terminal area, within perhaps thirty miles of the airport, represents the really difficult problem which must be solved before the full capabilities of existing blind approach systems can be realized. At present it is necessary to separate aircraft by long distances and to resort to altitude stacking during periods of poor visibility. This is an extremely unsatisfactory situation which, in addition to being hazardous, results in schedule delays and flight cancellations. The financial penalty is obvious.

It is believed that the features of Tricon, as enumerated previously, are particularly adapted to the solution of the complicated terminal area problem. Certain of these are emphasized, as follows:

1. The establishment of regular en route lanes, and the facilities for regulating traffic during en route conditions makes it possible for aircraft to enter the terminal area in an orderly fashion. Schedules would be such that, in the absence of an emergency situation, all aircraft would

Homer R. Oldfield, Jr.

Born in Mt. Vernon, N. Y., Major Oldfield graduated from Massachusetts Institute of Technology in 1938, and received his MS degree in 1939. After a brief period as a draftsman with the Glenn L. Martin Company he returned to M.I.T. as a research assistant and later as an instructor in the Instrument Laboratory.

He was ordered to active duty as a 2nd Lieutenant in 1941 and was assigned to the Coast Artillery Board, Ft. Monroe, Va. The following April he was transfered to the Antiaircraft Board, Camp Davis, N.C., as a member of the Electronics Section. He acted as AAAB observer during overseas service tests of the first antiaircraft gun battalion to be equipped with microwave fire control radar equipment. Attaining his majority in April 1944 he was assigned to the Office of the Air Communications Officer, HQ, AAF, in charge of the airborne radar fire control program.

Since going on inactive status in November 1945 he has been in charge of the General Electric Company's Air Force Section, Government Division, of the Electronics Department.

Major Oldfield is a member of the ASA, AFA, SPUG, Institute of the Aeronautical Sciences, and is a Senior Member of the I.R.E.

proceed directly through the terminal area to a landing.

2. The ability to establish tracks of any desired degree of curvature makes it possible to set up necessary traffic patterns with high accuracy.

3. The time sharing principle allows the establishment of alternate approach paths which are immediately available if a wind shift makes it necessary to change runways or runway direction.

4. The command facilities allow rapid communication to the desired aircraft at a time when speed of command is paramount. Thus, should emergency conditions arise, they can be dealt with in a "push-button" fashion by the controllers.

5. The push-button concept can be broadened to give the possibility of fixed control blocks. For instance, by means of the pre-set command system it is possible to establish fixed blocks of any desired length or width merely by throwing a master switch. It should be understood that these are "control" rather than "safety" blocks. The safety blocks are always tied to the aircraft and cannot be disturbed by any act from the ground. The control blocks will be fixed portions of space in which a distinctive command is heard.

6. It appears desirable to use one frequency for en route navigation and another for the terminal area. If this be done, the knob or push-button which changes frequency can simultaneously change the length of the safety block. This block should probably be shorter in the approach zone than in the en route zone. (It should be noted that the frequency shift can be made automatically, if desired, by means of a pre-set command from the ground. The necessity of this is open to debate.)

The Private Pilot

There are a number of schools of thought concerning the relation of the private flyer to the scheduled airlines and to the military. It is generally agreed, however, that the navigation and traffic control system must meet the full requirements of the most complex user. It cannot be compromised, else it will become useless. With this in mind, the Tricon system has been approached from the standpoint of solving the complete problem. The complete problem is not simple and it is wishful thinking to presume that it can ever be solved without some complexity of airborne equipment. Nevertheless, certain definite benefits accrue to the private pilot under the Tricon system.

The basic piece of airborne Tricon equipment is the navigation receiver, with associated counting and indicating equipment. Based on conservative estimates, this will weight perhaps thirty-five pounds and can be carried in most private aircraft which are equipped for instrument flight. With such equipment installed, the private flyer can fly regularly assigned Tricon airlanes, using routine communication channels to report his position.

The great majority of private aircraft will not be equipped for instrument flight, yet they must have navigation facilities and they must be integrated into the air traffic control system. It is assumed that, for reasons of economy, the only electronic navigation equipment which such aircraft can carry will be two-way, low frequency radio. That being the case, presently available low frequency facilities, such as the four course range, should probably be turned over to the private pilots as soon as the more elaborate facilities are available for the other users.

The traffic control problem, at airports which serve both the airlines and unequipped private aircraft, will never be easy to solve. The only feasible solution would appear to be the use of surveillance radar in conjunction with voice communications. Perhaps more realistic, considering future requirements, would be the use of separate airports, with low-frequency range paths paralleling Tricon airways and separated at a generous distance.

In summary, the Tricon system offers the following direct and indirect benefits to the private pilot:

1. The extremely small radio bandwidth required automatically frees a large portion of the spectrum for possible use by the private pilot. This frequency spectrum has previously been conceived as unavailable.

2. The basic airborne navigation equipment is very light, considering what it does, and can be carried by those private aircraft which might expect to be cleared for instrument flying.

3. The accuracy of Tricon is such that scheduled airways need not cover a large portion of the airspace. Thus there can be a useful number of secondary highways available to the private pilot.

4. The push-button communication feature provided by the Tricon system eliminates most of the voice communication usually necessary for scheduled airline operation. This gives the controllers more time to deal with problems relating to unequipped aircraft.

Ground Equipment

There is less ground equipment involved in the Tricon system than one might think at first glance. Although three navigation transmitters are required for one fifty mile airway, only one additional transmitter is required for the next airway section. Time sharing between these two airway sections allows two slave stations to serve both. Thus, for an airway of average length, there will be an average of two rather than three ground stations per fifty mile section.

Associated with each master navigation transmitter is a command transmitter-receiver. Although not essential, it is expected that this location will normally coincide with the location of an airport control tower or operations room. In this respect it is noted that there is no need to display traffic control data at the point where it is originally received. It is comparatively narrow band information, and can be transmitted to one control point for simultaneous display along with information from other airway sections. Thus considerable economy of ground display equipment is possible in regions of low traffic density.

There is no reason for any of the ground transmitting or receiving equipment to be attended by personnel except for routine maintenance procedures. It is anticipated that dual installations will be made, and that one of two Tricon receivers will be installed at convenient spots for monitoring purposes. These will switch stations automatically should triple coincidences fail to occur in the prescribed manner.

Airborne Equipment

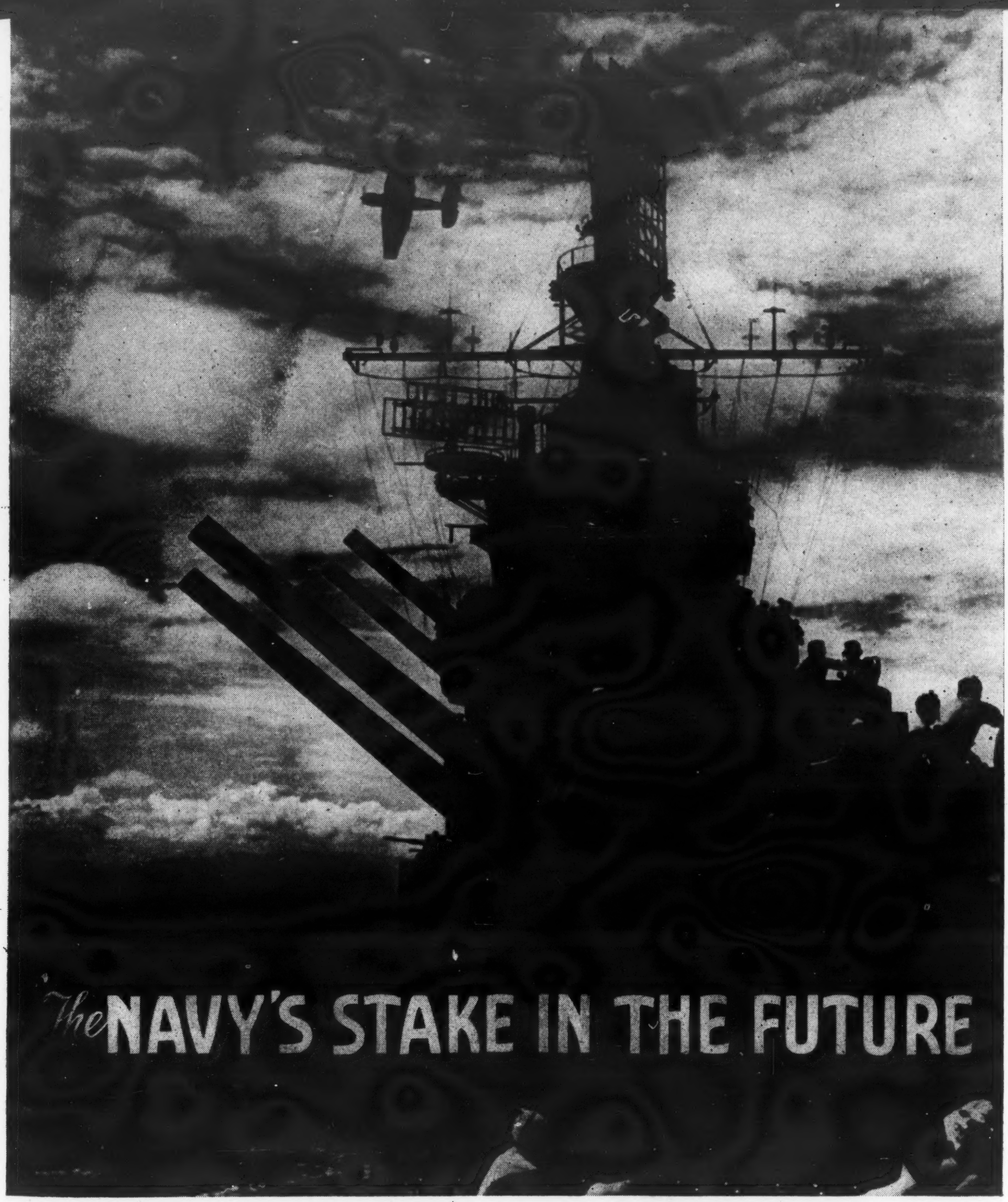
The weight and complexity of the airborne equipment is obviously a matter of considerable importance. Hence, estimates have been made in connection with the components which make up the airborne installation. These are subject to some variations up or down, but represent at least the correct order of magnitude.

1. Pulse Navigation Receiver—Expected weight, 35 lbs. Contains 35 tubes and occupies 1 ATR 7 inches high.

2. Annunciator and Identification Transmitter—Expected weight, 35 lbs. Contains 27 tubes and occupies 1 ATR 7 inches high.

3. Traffic Control and Block Signal Receiver — Expected weight, 20 lbs. Contains 24 tubes and occupies ½ ATR 7 inches high.

4. Indicator — Expected weight, 4 to 6 lbs. Probable size 4 inches square by 3½ inches deep. (Size and weight will vary depending on arrangement of indicating instruments and amount of information desired.)



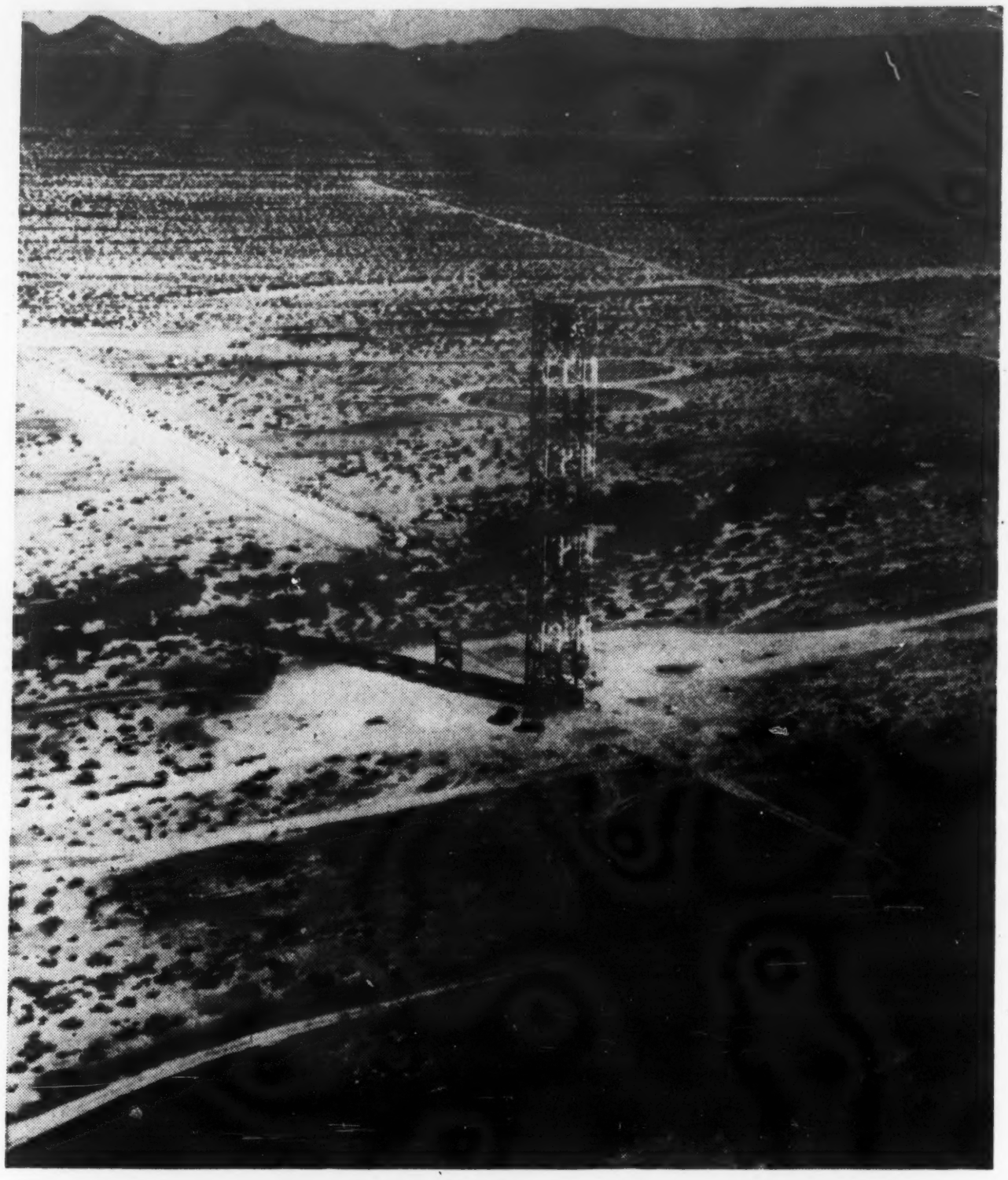
The NAVY'S STAKE IN THE FUTURE

By Major Guy Richards, U. S. Marine Corps Reserve

Two unhappy years of peace have brought full shares of confusion to civilians, statesmen, and members of the military and naval professions. Perhaps more than any other years in history, they placed new uncertainties over the future of military and foreign policies, domestic economies, and the balances of power between management and labor in industry and between national governments and a world government in the family of nations.

Until these years, it seemed, political and military sciences had been able to evolve workable conclusions by adjusting the old constants to the new variables. It is an axiom of the researcher that no science can be created from variables alone. Yet the last two years introduced an atmosphere of variables alone. They seemed to declare all the old constants unreliable. They brought so many novelties, of such magnitude, to so many fields of endeavor, that a characteristic national quandary has arrived in dozens of industries, professions, and sciences. The quandary is anchored to this simple question: Will any of the old rules endure?

Courtesy: U. S. Naval Institute Proceedings.



200 ft. tower in the Arizona desert for Navy's experiments with ultra-shortwave radio.

Upon the right answer to that question depends the outlook for all the sciences that pertain to men, nations, politics, statesmanship, economics, peace, and war. For if the answer is negative it is obvious that it is still too soon to make any new rules even if it is not too early to junk all the old ones. If only variables are left, if all the old constants have been disavowed, no new science can be created until some of the remaining elements are proved to be constants.

Among variables of the first magnitude which the two years of peace presented to the world are the following:

Powerful new weapons of mass destruction, including the atomic bomb, have not yet been outlawed—but it appears that they may be.

The United Nations, a new medium for curbing the aggressions of large and small powers, has not yet been proved a practical success. It appears, however, that it may.

None of the new weapons has yet reached a state of perfection wherein it has outmoded all of the old weapons—but some assertedly expert witnesses have announced that this will happen.

It is the purpose of this essay to show that despite all appearances to the contrary there are constants among the present variables. These constants follow a theme which links all the old weapons to all the new weapons. It links our military policies to our foreign policies and—if the theme is duly noted—it should guide them both. It also connects the prescribed roles of the Army, Navy, Air Forces, and Marine Corps in the defense of the United States with our obligation to furnish a share of the United Nations' security forces when and if the UN agrees on a plan.

Before this theme can be developed it is necessary to take a look at the material from which it comes. This material comprises the basic facts of the military and naval professions which appear to remain unshaken by anything that has happened during or prior to the past year. Here they are:

The science of electronics, and particularly radar, is the present ruler of most of the weapons in the Army and Navy and most of the new counter-weapons. Radar waves will travel to the moon and back on a straight line, but they won't curve around the horizon except under freak conditions. Operating distances inside 200 miles are likely to limit most radar devices in the immediate future, though the use of guided missiles in relay-association with radar may soon extend that range. The great abilities and limitations of radar, therefore, have a tendency to connect tactics to strategy and strategy to foreign policy in a manner that they have never been connected before.

Whether the objective is a rebellious foreign province or state, or an enemy nation, it appears to be as necessary as ever to invade, seize, and hold the objective before hoping to gain a decisive victory.

The bulk of overseas tonnage will be freighted by ships, in war and peace, for many years to come. Therefore, the importance of sea power will persist for many years to come.

Characteristics of all the new weapons indicate that the speed factor in action and reaction will continue to increase in importance. The cost of errors and unpreparedness will become proportionately higher.

Cruising maritime and naval targets offer less effective results to atomic bombardment and attacks by long-range rockets than fixed land targets.

Americans place a higher value on human life than the citizens of many other nations. This fact is accompanied by certain military liabilities. It means that there are several degrees of military and naval success, short of a total invasion and conquest of the United States, by which our enemies could gain advantages highly embarassing to this nation.

Out of these two arrangements of facts, the variables and the constants, important conclusions can be drawn which constitute a reasonably accurate estimate of the situation for several years to come. In this estimate can be found the general outline of the size and scope of the Navy's role in the future of the United States.

The approach is best made through the subject of radar, the electronic agent which now serves the Army, Navy, and Air Forces with about equal prominence. Radar's ultra high frequency rays provide almost foolproof range and direction finders for naval gunfire. They provide for warning and interceptive action against planes, guided missiles, and rockets. They assist, with television

rays (their first cousins on the high frequency bands), in the aiming of our own missiles and rockets. They enable our bombardiers to hit targets they can't see in their bombsights. They enable our anti-aircraft gunners to hit enemy planes and missiles that can't be seen from the ground. They enable our searchplanes and scouting forces to locate and appraise enemy naval formations concealed behind fog, rain, or clouds.

In short, radar has brought the greatest extension of human visibility since the invention of the telescope. It requires no imagination to observe that the United States must have a protective screen of radar-operated alarms and countermeasures if it hopes for any security or interval of warning in a future war. What kind of a screen that must be can be gleamed, not only from radar's power to travel thousands of miles through air and through airless space, but also from its limitations — from the fact that it won't curve around the horizon; that it is virtually inoperational through water, wholly inoperational through land; and that, like the human eye, it will go no further than the line of sight permits. There is a bare suggestion that some day this limitation may be removed. The behavior of lift-frequency microwaves in the upper atmosphere has hinted at the possibility that the waves may be bent and made to pass around the world. If so, radar observers in a single locality may be able to follow the movements of planes and weapons in the air in any part of the world. That development is a long way off, however, from all the evidence now available. Radar's maximum operating distances from instruments on high mountains or high-flying planes are indicated for several years to come to be between 200 and 250 miles.

Thus an all-around perimeter defense for a nation surrounded by land, water, and islands calls for a protective screen strung over land, ships, and islands bases. It calls for outlying bases with ground instruments. It calls for radar-equipped ships and search-planes and a well-deployed network of bombers, fighters, and interceptive countermeasures. Outlying bases mean sea-lanes and air-lanes kept open by the defender. Open sea-lanes mean ships secure from attack. Convoys of ships require local air coverage and protection from attacks by submarine and surface units.

The protective screen, furthermore, must not only be built on the principle of a close-in defense. It must be thrown out, too, as far as possible. Otherwise it will offer no increment of warning against supersonic rockets, whose upflight and midflight can be plotted by radar, but whose plummeting downflights are too speedy and too imminent to allow for successful counter-action.

Until the air-ton-mile displaces the sea-ton-mile as a medium for heavy transport (and that, too, is a long way off) and until better means than radar can provide advance warnings and quick countermeasures, our screen must consist of land-based and sea-based radar instruments, some on islands, some on ships, some on land-based planes, some on carrier-based planes, and some on submarines able to take their radar observations close to the enemy's shores.

That is the central theme of our minimum requirements for defense. It is not by any means enough for a victorious counter-offensive, however, and it is not enough even for a prolonged defense.

Countermeasures Against Distantly-Launched and/or Guided Missiles

The long-range rocket, the guided missile, and the necessity for protection against them, are with us as a present menace and a present urgency. The trans-oceanic rocket, it seems likely, is not many years away. Never tried, but designed by Nazi scientists, were several improved types of V-2's—the A-9, with a theoretical range of more than 1,500 miles; the A-10, with a theoretical range of 3,500 miles, and the A-14, about which all information is still

The submarine may be the battleship and aircraft carrier of the future.

on the American secret list. Enough information has leaked out to the general public to indicate that all the big nations are busy trying to improve on the aiming controls and 350-mile range of the V-2 type rockets, and it can be taken for granted that the performances of the A-9, A-10, and A-14 will not be long in passing from the drawing-board to reality. In the guided missile department the variations and improvements on the German's buzz-bomb and glider-bomb are even better known and include such devices already anounced by the War or Navy Departments as the Glomb, a television-aimed glider bomb; the Flying Stovepipe, a 1,500-mile-an-hour ramjet engine which may soon be attached to a missile; the Gorgon, a radio-controlled, target-seeking rocket; the Gargoyle, a 1,000-pound armor-piercing glide bomb, controlled by radar; and several others, still highly secret.

From the standpoint of the defender, all of these weapons have one thing in common. Radar provides the earliest warning against them and the best means of plotting their progress. Radar also provides the best means of intercepting and destroying them in flight, whether they are slow enough to be tackled by *ack-ack* or planes with radar equipment, or so fast that nothing can be employed against them except the new anti-missile weapons such as the GAPA rocket, a supersonic device already brought to a high state of development by the Army.

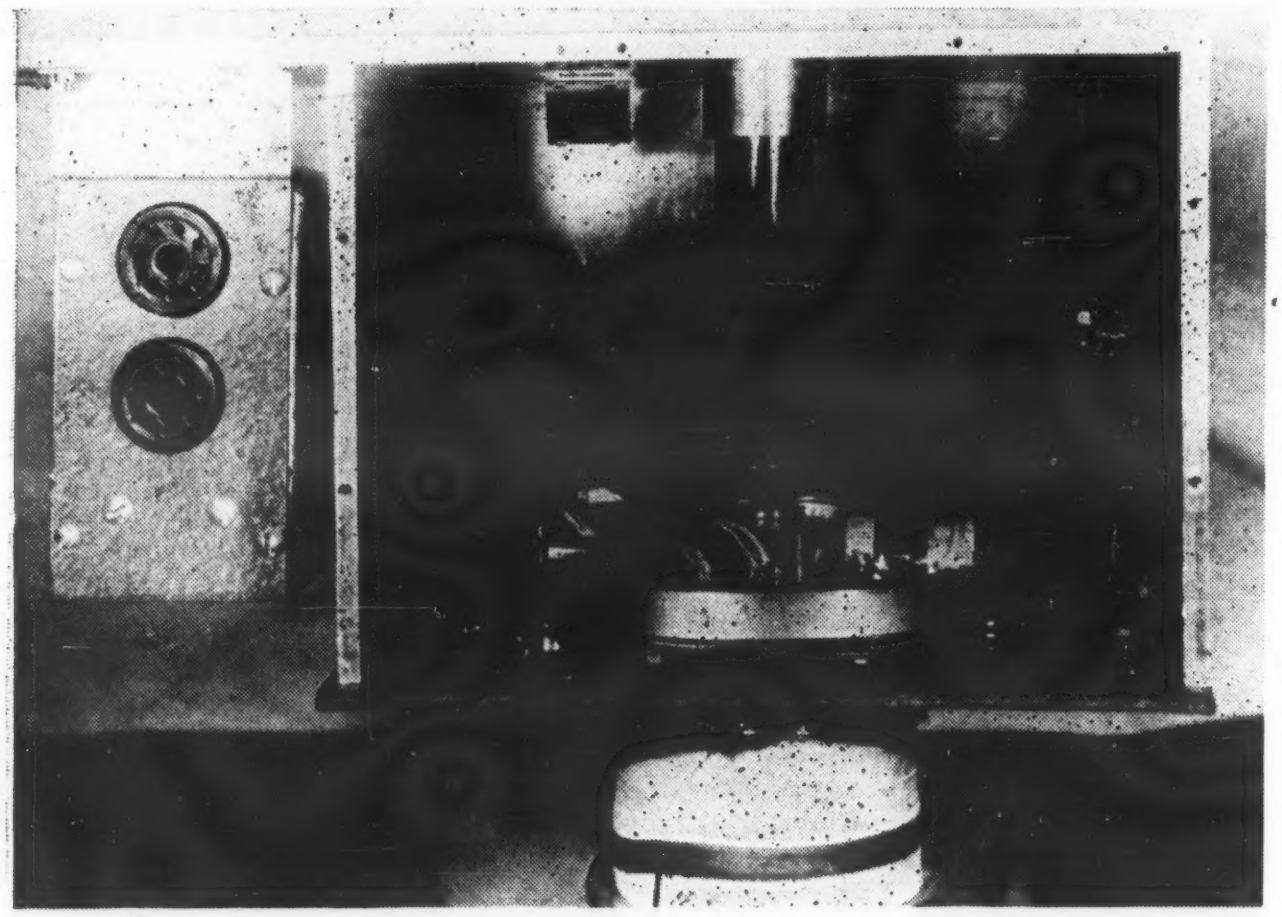
Several important deductions can be drawn. One is the advisability of having radar-detection stations emplaced in a thick network around the United States to give as much warning as possible and to enable plotting the courses and speeds of the invader's weapons for the purpose of interception. In theory, a rocket 60 miles above the earth's surface would be detectable by radar about 700 miles away. In practice, ranges inside 200 miles, and better still, inside 100 miles, bring more efficient results. Obviously, therefore, it is better to have the network pushed out as far as possible as well as brought in as close as possible. That means islands in our adjacent oceans and seas should be included in the network. It means that nations on our borders should be invited to participate in our network.

Another deduction is the advisability of having launching-sites for anti-missile weapons abundantly distributed throughout the same network. Another deduction is the urgent necessity for filling in the network over wide areas of the oceans where there are no islands. This is the Navy's job. In times of alert, especially, it will require a careful distribution of surface vessels and carrier-based aviation.

Another deduction is the advisability of having the fighters and attack-bombers of our Air Forces deployed in our advance bases in order to reinforce carrier aviators and bring counter-action against whatever enemy planes or ships are serving as missile-launching or missile-guiders.

All deductions show that the Navy, the Air Forces, and advance bases will be as vital in the atomic-rocket-radar age as they were for somewhat different reasons in the aero-amphibious age of World War II—but the timing and teamwork will have to be even faster. To keep the sea-lanes open to the advance bases and to all locations on our network; to supply them; to reinforce them if they are endangered; to recapture them if they are seized by hostile air-borne or sea-borne forces—all these are tasks in which the functions of the Navy, the Marines, the Air Forces, and the Army's air-borne divisions are too clear to require further elaboration.

Steel ball spins at 1,800 MPR in Navy paint test.



Countermeasures Against Long-Range Bombers

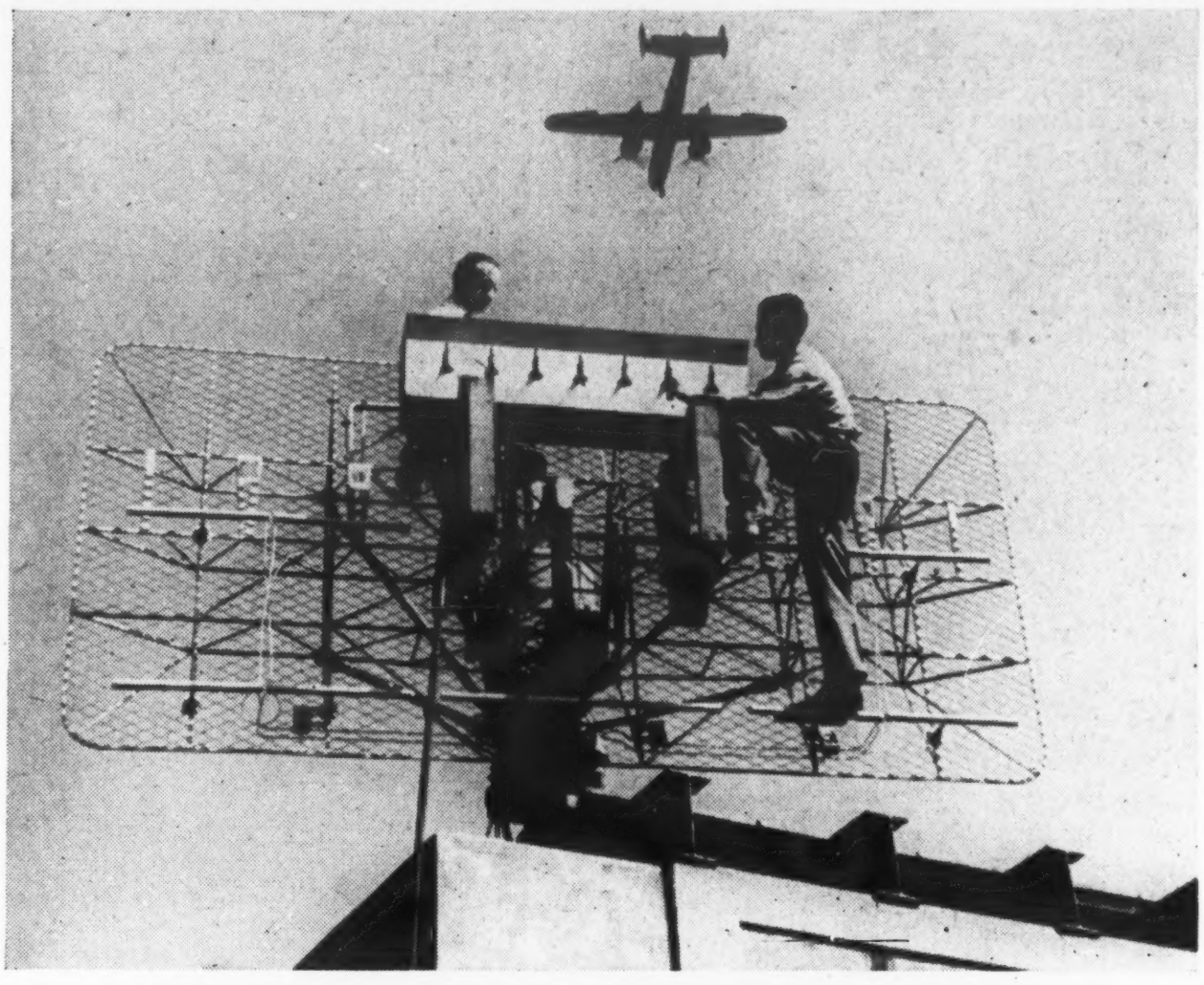
Future security against enemy air attacks demands the same network of radar, alarms and countermeasures already described. Furthermore, until the anti-missile rocket and proximity fuze *ack-ack* become as effective as the fighter plane against high flying aircraft, present requirements call for squadrons of fighters and search-planes in our outlying network for protection against attacks and invasion from aircraft. Naval aviation and the U. S. Air Forces must share this burden together.

Countermeasures Against Invasion by Sea

(1) *With Air-Borne Ground Forces.*—The threat of a paratroop invasion, whatever its objectives, imposes the need for the closest kind of synchronization between the air arms of the armed services and the command of the Ground Forces. Wherever the staging area of the paratroops, it is likely that the dictates of deception, diversion, and concealment will route the enemy's approach over water for as much of the air-trip as possible. Here the defensive roles of the Navy's carriers deserve mention. These vessels will soon have almost as much all-around fighting power as an island base. When fully equipped with radar-sighted rockets, jet-propelled fighters, and high altitude, proximity-fuze *ack-ack*, they can be relied on to take a sizable toll from any invasion force encountered over the sea.

(2) *With Sea-Borne Task Forces.*—The Navy's mission in resisting attacks by battleship or carrier task forces needs little discussion, and even the public can remember such classic examples from World War II as the Battles of Midway, Leyte Gulf, and the Philippine Sea. Is this mission of the Navy still the same, or has it been changed? The answer is that it has not been changed. The effectiveness of land-based aviation will always increase as the invasion or attack force draws closer to land, and will always decrease as it recedes. Eventually it is possible that one or two pilots bringing shore-launched,

television-aimed rockets down on moving naval targets will prove more effective weapons than carrier aircraft or naval gunfire or ship-launched missiles and rockets. But until television and radar can be "turned" around the horizon, the human eye, either at the radar screen, computing range and direction data, or over the target, computing fire control data, will impose a big margin for error on the realization of all-weather, all-distance fire perfection for any weapon — rocket, missile, robot plane, or naval rifle. Either an enemy weapon or an enemy force may elude the human eye on the radar screen—a possibility increased by enemy "jamming" or counter-radar. Or the human eye and the human mind will make errors in target calculations. Or bad weather over the target will hamper forward observers in providing fire control. Despite all known advances in weapons and electronics, it is still more than a rare possibility that two opposing naval task forces will close within gun and rocket range, by day or by night, in weather inoperational for planes, and be forced to slug it out without benefit of carrier aircraft or even aerial spotters. This fact emphasizes an interesting characteristic that has been true of naval affairs since the turn of this century. The new weapons don't erase the old weapons. The new rules don't erase the old rules. There has been a constant addition of new techniques, but they simply add to the total without relieving the naval tactician of the necessity for being prepared for all the old contingencies. Thus, nothing occurred in World War II, or at Bikini, or in the laboratories of the combatants, from information recently revealed—and nothing has happened, to this writer's knowledge, on any postwar drawing-board — which suggests that there will not always be explicit continuing uses for the battleship, the cruiser, the minesweeper, the tug, the destroyer, the submarine, the carrier, the net tender, and many other vessels whose origin dates back a varying number of years. Their functions may combine with those of other vessels to make it possible to scrap a type of ship for a new composite type, but the functions seem to go on forever. The new ships of World War II, such as the LST's and LCI's, and the new ships of the postwar era, such as the rocket and guided missile control ships, the *Kentucky* and *Hawaii*, have all added new functions to the Navy, but they have subtracted no functions from the Navy. This is a point little understood by the general public. The



Radar rules most of the weapons and the new counter-weapons.

fact is that the airplane, the rocket, the guided missile, and now nuclear energy, will all eventually be found to have added to the total of naval techniques without having removed a single one. Far from becoming more limited and simplified, the Navy's destiny seems definitely assured new importance and complexity by almost every new advance in science. This trend is likely to continue until that distant and conjectural day when ships and ocean trade have ceased to exist.

(3) *With Submarine-Borne Ground Forces.*—It is sometimes forgotten that the submarine was one of the most potent weapons of World War II and that, as the war ended, a great counter-weapon to the submarine had yet to be invented. American submarines sank 94 of the 331 naval vessels lost by Japan. They accounted for 1,750 of the total Japanese casualty list of 3,129 steel merchant vessels. Our submarines reduced the supply-circulation of the enemy's stolen empire to an anemic trickle. German submarines, in 1943–1944, came dangerously close to squeezing the Western Hemisphere out of its ability to influence the course of the European campaigns. Larger, faster submarines, with greater carrying power and longer periods of submersibility (25-knot speeds, 22,000-mile ranges, 72-day submersion) have already been constructed by the Germans. The American, British, and Russian Navies have the data on them. Fleet Admiral Nimitz, an old submariner himself, has expressed the opinion that all navies, including our own, will invest more attention than ever in this weapon and some qualified observers predict that the battleship and aircraft carrier of the future will be a submarine.

The submarine's offensive roles as a scout and a raider could easily be extended in substantial magnitude to include the functions of launching missiles and carrying troops. Submariners believe our present fleet-type vessels could withstand the launching "kick" of missiles up to 10,000 pounds. The 2,400-ton American submarine *Argonaut* carried 133 Marines from Pearl Harbor to Makin Island, stood by for two days under an enemy air screen, and took the survivors back to Pearl Harbor again.[1] Obviously larger submarines could launch larger missiles and carry larger units of troops. All signs are that future construction may follow those objectives.

The unharassed, secret movement of submarines is not greatly threatened, particularly at depths below 300 feet, by existing anti-submarine devices: the sonic detector, not very efficient above 4,000 yards; the magnetic airborne detector, reasonably efficient for locating a submerged submarine if the searchplane intercepts its general area, but only roughly accurate in bringing counter-weapons to bear for the simple reason that the counter-weapons in themselves are not very efficient and not very easy to control; the shipborne depth bomb, almost wholly impracti-

[1]The *Nautilus* accompanied the *Argonaut*, carrying 89 Marines.

cal for use by ships slower than the submerged speed of the submarine and requiring a hit or a close near-miss to bring any results; and the air-borne depth bomb, which is dependent on many variable factors for success against a fast-moving, deeply-submerged target.

The German submarines of 1943–1944 were not equipped with the *Schnorkel*, or breathing tube. The necessity for them to surface, in order to recharge their batteries, and the efficiency of radar in spotting them on the surface, combined to defeat the German submarine blockade of World War II. However, if we had been confronted by large numbers of the submarine type the Germans were building at the end of the war, the story might have been different. This was a 1,200-ton, *Schnorchel*-equipped craft with three power sources: Diesels for *Schnorchel* depth cruising; batteries for deep, depth cruising; Walther gas turbines for producing 25-knot bursts of speed, during battle emergencies, at great depths. The Germans had also experimented with underwater rockets ejected from tubes that could be trained and elevated like naval rifles.

There are several conclusions to be drawn.

The submarine, as an offensive weapon, has a brilliant future. The Bikini Test served to confirm this by proving that the cylindrical steel designs of the underseas craft anchored in Bikini Lagoon withstood both explosions better than that of the other vessels.

Defense against the submarine requires highly-integrated use of all the countermeasures here described. All but those countermeasures which involve the employment of aircraft are purely naval countermeasures. In theory, there is no reason at all why the pilots and aircraft of the Army and U. S. Air Forces shouldn't be assigned anti-submarine patrols that cover our coastal waters, and maybe they should be. This matter has been the subject of heated dispute since the first day of the last war. It is clearly an assignment for carrier aircraft on the long, offshore reaches, and providing cover for our convoys. So is the matter of sonic detection a naval assignment. So is the matter of bringing counter-weapons to bear from fast DD's and DE's.

In short, the defense against the growing menace of the submarine is almost as much a naval responsibility as that of making sure that our own submarines realize the immense offensive possibilities of future submarine warfare.

This depth charge blew a German sub to the surface. Many were sunk, but the German sub offensive nearly succeeded.

A dissenting opinion might intrude here to ask these questions: Why should submarines worry us? Only the defense of the British Empire, only the defense of Western Hemisphere trade, only the defense of ocean trade makes us need to worry about subs, isn't that true? Why does the defense of the United States involve itself with a defense against submarines?

The answer is threefold. This nation is not economically self-sufficient either in war or peace. To stoke our war plant we must be able to import a steady flow of sea-borne materials. Secondly, we cannot defeat an invader unless we carry the counter-offensive to his own backyard, which means carrying troops and equipment there. This will be taken up in more detail under the section "THE NAVY'S PART IN A COUNTER-OFFENSIVE." Thirdly, the rapid development of radar and electronic interception devices suggests that the days of the troop-carrying airplane may be ended far sooner than the days of the troop-carrying submarine. Neither radar nor radar devices are any good against a submerged submarine. The surprise invasions of the future may come from under the sea.

The Dilemma of Atomic Weapons

Confusion over the power and future of atomic weapons served in several ways during the past year to sabotage the armed forces. It placed an air of uncertainty over the value of the war-tested doctrines of the Army, Navy, Air Forces, and Marine Corps. It produced a series of contradictory conceptions in the minds of Congress and the public by which it appeared (a) that we spent a national fortune developing the atomic bomb; (b) that the bomb required us to spend another national fortune redesigning and rebuilding our Navy, weapons, equipment, bases, cities, and harbor against atomic attack; (c) that atomic weapons must be, and will be, outlawed, in which case we would revert to the *status quo* and would not have to rebuild anything or even fret very much about the Army and Navy — the United Nations will take over the whole security problem.

As the year 1946 neared its end, the United Nations Atomic Energy Commission voted 10–0 to accept "the principles" of the Baruch plan for unvetoed international control and inspection of the atom bomb and atomic energy. Coupled with the past history of all horror weapons, like poison gas, after they are possessed by more than one side, and with previously encouraging remarks from Soviet Foreign Minister V. M. Molotov that the veto would be "irrelevant" once a disarmment plan had been agreed on, there are reasons to believe that Hiroshima and Nagasaki will be the last examples of nuclear fiission used as an instrument of war. There are also reasons always to be slightly doubtful that Hiroshima and Nagasaki will be the last examples.

In other words, there is some prospect that all horror weapons, including atomic weapons, will be outlawed by two evolutions of events: (1) the United Nations and its enforcement

agencies; and (2) the natural checkmate that has restrained the use of gas, germ warfare, and even area bombardment from the air, when it seems that reciprocal devastation is invited before the attacker can make a knockout blow.

At the same time the prospects can never be wholly excluded that we will find ourselves in an atomic war, despite all assurances to the contrary. A persistent attitude of mental reservations about the Baruch Plan, among some members of the United Nations, was borne out even in the final voting, on December 20, 1946, when the matter of unvetoed control was ratified by the UN's Atomic Energy Commission.

At any time, and even at the apparent zenith of its power and workability, the United Nations could collapse as a practical organization. Or a powerful member could dishonor all its pledges and jeopardize the security of other members. The very safeguards of control, enforcement, and inspection, which are part of the Baruch Plan, should serve as constant reminders of the possibilities for one or more nations to deceive all the others, and these reminders should be overlooked least of all by the leaders of our armed forces. As usual, when everything else fails, it is their duty to plan and mobilize the countermeasures that lead to victory over our enemies.

In addition to this nation's share in the UN's enforcement and inspection machinery, therefore, it is fitting to point out that the second line of defense against atomic attack is nothing other than the same defense that our Army, Navy, and Air Forces must be prepared to offer against all contingencies, any one of which could materialize into atomic warfare —saboteurs, rockets, missiles, aircraft, paratroops, surface vessels, super-submarines, and ground troops. Any one of these could be the medium for launching an atomic war. Since the Navy's role in a defense against them has already been described, it need not be repeated.

However, the Navy has an additional defensive role in preparations against atomic attack. And that is to prepare itself for the eventuality—up to the limit of the law—of being forced into the use of atomic weapons in pressing its counter-action against an international outlaw. For if this outlaw should employ atomic weapons, there would be no other recourse for the United States, either as enforcement agent for the UN, or as defender of its own territory, to respond in kind. Failure to do so, in fact even a prolonged delay in doing so, would prove disastrous.

The menace of atomic weapons bears two other hints which I am sure will not be lost on the Navy. The most likely carriers of atomic assault—the plane, the rocket, the guided missile, and the submarine firing underwater rockets—probably will always have more trouble finding moving naval targets than finding fixed land targets. Thus, their initial assaults probably will be aimed at congested military and industrial land targets where radioactivity may be expected to keep on taking its toll long after the explosions.

A moving ship, position unknown to the enemy, therefore may well be the next-to-safest place in an atomic-rocket-missile war. A submerged submarine, position unknown to the enemy, may well be the safest place. In view of these facts, the Navy's capabilities for carrying the offensive back to the enemy are clearly manifest.

Wars have never been won by indestructible weapons for the simple reason that none has ever been invented. They are won by destructible weapons and elements that survive. There is no doubt that in an atomic-rocket-missile war, a large portion of the Navy's weapons and elements would survive, and it is more probable than possible that they would prove our best means of pressing the counter-offensive and gaining the victory.

The Navy's Part in a Counter-Offensive

Our Navy's share in winning World War II is so well known that it would be superfluous to review it at great length. A beachhead stood behind every military decision won by our forces in the Pacific, North Africa, and Europe. Clearing the way to that beach-head, winning it, protecting it, and resupplying it was a joint triumph of the Navy and the amphibious landing doctrines perfected by the Navy and Marine Corps from lessons learned in more than 160 landing operations since the days of the Revolution. As General Alexander A. Vandergrift, then Commandant of the Marine Corps, testified before the Senate Naval Affairs Committee:

"Even as early as 1921, The Marine Corps accurately forecast the exact pattern of the coming war against Japan. We were impressed by its amphibious character, but the sombre lessons of the Dardanelles Campaign were fresh in our minds, and we resolved that the coming amphibious war would not involve a repetition of the shambles of Gallipoli. We devoted all our efforts and most of our slender resources to the task of analyzing the Dardanelles failure and developing a modern amphibious technique which would bring together the land, sea, and air forces in united action in execution of this most difficult problem in warfare—the major landing operation. In conjunction with the Navy we provided the nation with a doctrine, technique, method, and equipment which became the standard pattern of amphibious warfare adopted not only by our own Army but by the armies and navies of eight United Nations as well. It proved to be the key to victory in every major theater of war, and I believe it to be the most important contribution any American service has ever made in the field of purely prospective development of a form of major warfare."

Even with formidable air power, the Germans, for lack of amphibious equipment and technique, found themselves unable to cross the English Channel to invade the British Isles. To some members of the public the phrase "amphibious doctrine" is simply a fancy designation for a boat-ride; but professionals are well aware of the hundreds of technological hazards that had to be overcome to perfect the American landing doctrines and the bow-landing, bow-unloading, and self-withdrawing features of the LST's, LCI's, LCM's, LCT's, the Alligators and Buffaloes, the Ducks and Amphibious Jeeps, that forged a gangway between the Navy and the enemy-held shores.

This specialty was probably the greatest American contribution to victory that remained unrivalled by either our allies or our enemies. The proposition to be examined is whether or not its importance is likely to continue. Do recent events show that it is likely to be proved obsolete and inconsequential in future wars?

The answer need not provide the whole solution to the Navy's part in a counter-offensive; but if the beach-head problem is going to continue, it will be agreed, I believe, that all of the classic naval problems will continue insofar as they relate to control of the seas by a trans-oceanic power on the offensive.

Two arguments might be advanced that the naval beach-head no longer must be secured by a trans-oceanic power on the offense. One argument could be based on the theory that the next war will be a Buck Rogers War inter-continental rockets and missiles, an affair of a few minutes or a few days, in which the decision will be won by robot weapons. Another argument could be based on the theory that the next war will be won by airborne troops which, after a preceding barrage of rockets and missiles, will swoop down on the enemy's territory from a sky-blackening armada of planes and gliders.

Few professionals lend much credence to the first theory; but even if they are wrong, it won't make much difference. If any weapon could

knock out, in a few minutes, or in a few days, a nation the size of the United States, it would deprive the attacker of most of the benefits of victory; it would pose the uncertain threat of being unleashed on him at nearly the same instant; it would be more terrible than anything yet devised, including the atomic bomb; the temptations to use it would be greatly exceeded by the palpable disadvantages of using it; if eventually such a weapon is invented and used, there will come a time when the attacker wishes to seize and hold the territory he has gained with it; so eventually the problem introduced by the first conjecture flows naturally into the problem introduced by the second conjecture.

The second conjecture has much to support it. There is not an important nation which hasn't been alerted sharply to the future importance of air-borne troops; and only a week before Christmas, General Jacob L. Devers, U. S. Army Ground Forces Commander, announced revolutionary changes in the size of our infantry and armored divisions, one of which is designed to make it possible to "lift" every infantry division in the army and fly it to the battle scene, *providing an adequate airport is in our hands.*

Few will dispute that the day of the airborne division and the air-flown infantry division is here. A review of their performances during the past war shows that paratroop missions fell into two broad classifications: (1), scout, commando, and spy jumps often made deep inside enemy lines; and (2), battalion, regimental, and divisional drops made inside and close to enemy lines and planned to link up swiftly with our own ground forces. No paratroop drops were made by the Allies against strong enemy forces in the last war that did not call for quick consolidation with friendly ground forces; and it is notable that in the one instance, at Arnhem, when consolidation could not be quickly effected, the First British Airborne Division was forced to withdraw after heavy losses. There were many successful movements of air-flown American infantry regiments and divisions, starting, I believe, with a mass-flight conducted by the Fifth Air Force from Australia to New Guinea, in 1942, with troops for the Buna Campaign.

The Summing Up

It has been demonstrated that the radar-rocket-missile age has been true to the history of all previous advances in the arts and sciences. The age has added greatly to the Navy's responsibilities without relieving the Navy of its older functions. The science of electronics, and its importance in the scheme of perimeter defense, has tended to place on the Navy a new burden relating to the defense of the United States against rockets, missiles, aircraft, and air-borne troops. The great destructive power of the new weapons has tended to underline the importance of the new speed and co-ordination with which the Navy must be prepared to play its part in the counter-offensive. Even the importance of sea power has been enhanced. Twenty-five years ago the oceans were not only supply-routes, but bulwarks of our defense. Now they are not only supply-routes but broad, uncrowded avenues of approach by which new weapons can arrive with potentially greater secrecy than over the land.

The Navy now has more urgent jobs to do than at any time in its history. This is the conclusion reached by this writer from all the facts available to him. If he is not wrong, it is inescapable that every member of the naval profession should help make these facts known to other Americans before it is too late for the Navy, through lack of men, time, training, and material, to meet these challengers and perpetuate its great traditions. The truth is, and all Americans should know it, that the Navy's stake in the future is no less than the future's stake in the Navy. Both are immense. Each is inseparable from the other. The contingencies now faced by the armed forces require immediate strengthening of them all, including the Navy, before this nation becomes an extreme example of undefended wealth— an alluring invitation to aggression as a potentially poor ally, but the richest and juiciest target on earth.

Rockets in the assault on Okinawa.

ARCTIC AURORAL RADIO PROBLEMS

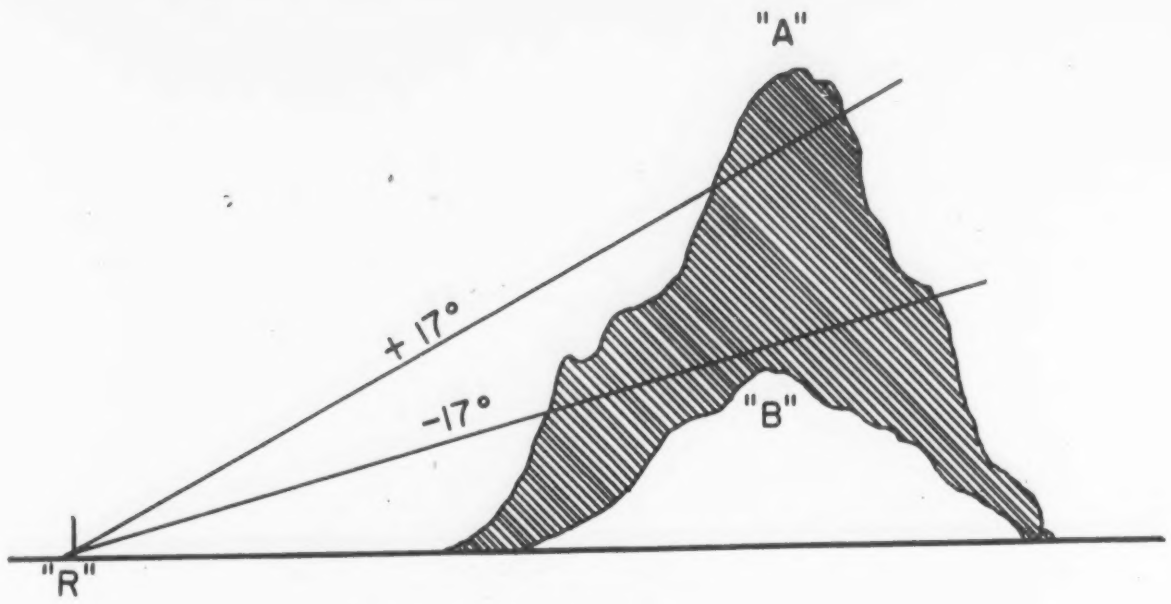
By Lt. Col. Paul C. Oscanyan, USAF

HQ. Airways and Air Communications Service

The aurora borealis is one of the most beautiful facets Nature turns toward man. The newcomer to the northern regions never tires of watching the silent flickering lights. There is felt a fascination akin to that of gazing into the flames in a fireplace.

But to the radiomen operating in those regions the aurora is a pain in the frequencies. To them it just spells interference. The action of the aurora and magnetic storms, with extended periods of daylight and darkness, alter conditions so that new radio techniques and procedures are made necessary.

In the Greenland-Iceland area the north-south difficulties in radio contacts become more marked. The general rule is that it will be necessary to use a much higher frequency than is "normal" for the distance involved during any given time of day. For example, 12 MCS should be sufficiently high for daytime communications most of the year between New York and Reykjavik, or a point northward and equally distant from New York. Experience proves however, that 17 to 18 MCS is far more reliable during all but a very short time of the year during midwinter. The general rule is to greatly increase



MOUNTAIN "A" OBSCURES RECEPTION AT "R"
HILL "B" BEING BELOW THE 17° ANGLE
DOES NOT OBSCURE RECEPTION AT "R"

—Data By: Cmdr. J. L. Reinartz, USNR
Lt. Col. P. C. Oscanyan, USAF

Diagram A

the normally indicated frequency.

Periodic fading is not so common as in the lower latitudes, possibly because of the more stable condition of the ionosphere. However, the aurora, though naturally invisible during daylight, generally gives visual indication at night of fading and blanketing effects to be expected, also their duration. Experience and observation soon teach the operator and supervisor to identify and cope with the several special conditions.

Static in its usual forms is almost non-existent. In general the wintertime produces the most since the snow, hail and graupel, as well as heavy blowing snow will produce static discharges. Rain static is common in Iceland. Static drain resistors therefore are useful equipment.

Radio conditions will often be found to be difficult progressing up the narrow and steep walled valleys and fjords of these countries. In locating ground stations a simple rule can be followed, eliminating most of the difficulty. Briefly it is this; when the station is located close enough to a hillside to make its rise more than 17 degrees above the horizon with relation to the station, then signals will be screened or shadowed out. See diagram A.

It will be realized that this rule applies most directly to high frequency, low angle signals coming toward the receiver. It is quite possible that this screening effect can be used to advantage in locating antennas which will thus have directional characteristics for reception, in that signals will be screened off if they come from a direction purposely obscured by the location of the antenna.

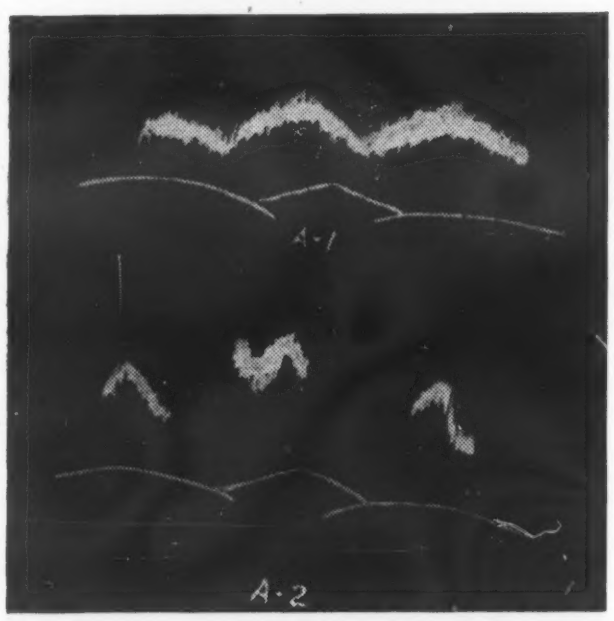
Beam stations for aircraft have been located at suitable points but the problem of servicing and maintaining them remains a major one. due to weather and conditions of water navigation.

During the time of almost continuous daylight there is very limited interference, if any, on the middle and lower frequencies and good use of this fact might be made by stations which wish to limit their range. During the periods of extended darkness the other condition obtains and it is easily possible to get excellent reception results with poor, or comparatively poor, equipment.

It will be seen that, due to geophysical conditions in the Arctic. it may be essential to locate some of the radio aids to military or civil airways at some distance from the field itself. This complicates the problem only because extensive landline facilities are generally impossible.

Aurora has long been classified as

Classes A1 and A2—Low and Intermediate Frequency classes.



to type and action, yet there is no generally authoritative definition of what it is.[1] Science has been frustrated by the height of the display above the earth and its rapid changeability. It has been classified as an electronic bombardment of certain gases of the upper air.[1]

During the author's stay at the Mt. Evans Observatory of the University of Michigan Expedition[2] to Greenland in 1927-28, he had the good fortune to witness many auroral displays and to be in a position to note their possible effect upon radio signals as received at that point. The observatory was situated some 1200 feet above sea level and gave an unobstructed view of the entire horizon. The receiving equipment of the radio station covered the radio spectrum from 15 to 30,000 kc. A special short-wave receiver covered the higher frequencies and a regular commercial receiver with loading coil unit was used for the lower frequencies.

For purposes of illustration let us here divide the aurora into a series of classes so the meaning of what is here set forth will be clearer.

Class A1—Low and Intermediate-Frequency Interference Class

The type causing interference on the low and intermediate frequencies is similar to a suspended curtain. It appears to the observer to be touch-

[1]Physics of the Air, Humphreys, N.Y.C., 1929.
[2]Prof. W. H. Hobbs, Director.

Classes B1, B2, B3, B4—High Frequency Interference classes.

ng the horizon and extending for a relatively short height up into the atmosphere. It varies in apparent density and in constancy of situation and duration. During displays of this class, the interference manifests itself as a form of marked fading. Signals of the intermediate frequencies (300 to 500 kc.) swing in and out, in fairly direct proportion to the auroral change. The observed aurora in these cases was extending its field of visibility across the horizon between the receiving and transmitting stations. The effect upon lower or higher frequencies was not noticeable. Diminution of the effect was reasonably relative to the variation from the mean of the frequencies observed to be affected. Limitations as to observable signals somewhat hampered us because of our being located at such an out of the way corner of the world. Ship stations moored in quiet harbors were our best sources. Signals from vessels on the transatlantic route and from Reykjavik, Iceland, also were affected and therefore added to our source of signals.

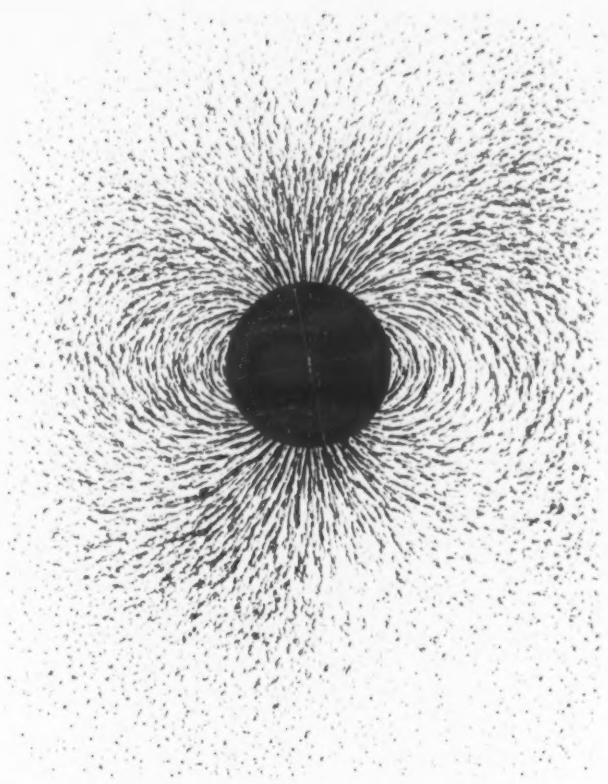
Class A2—Variable Interference Class (Low and Intermediate Frequency)

Owing to the scattering of the A2 variable interference class of aurora, the effect upon any set of signals in a given frequency band was not so marked and of necessarily short duration, inconstancy being often a feature of such displays. The border line of auroral classification, insofar as radio is concerned, lies near this class.

Classes B1, B2, B3, B4—High-Frequency Interference Classes

Because of the large number of high frequency stations on the air at practically all hours, the high frequency interference classes of aurora were best observed. This type of aurora starts in the western or southwestern sky and is well above the horizon. Its direction of movement and apparent density are generally quite constant and the change in appearance progresses as in B1, B2, B3, and B4. The effect upon the received signal varies as shown in the direction of the arrow, "S," from normal, down to inaudibility and thence back up the scale again until the display has passed on and the field of its influence has gone with it. The movement of the display is in the direction of the straight arrow pointing nearly toward true north (N).

What really offers the most interest is the fact that there seems to be a point which can be calculated. When the corona formation is nearest to 17 degrees (or more) above the horizon, and between the receiving and transmitting stations, the signal is most greatly influenced. It is interesting to recall the experiments conducted by an expedition in 1926 to ascertain the angles and effects of topography on the possibilities of reception, especially short wave signals. It was found that the corona of these classes of aurora is of considerable atmospheric depth and, therefore, its action will extend over a large reception area.



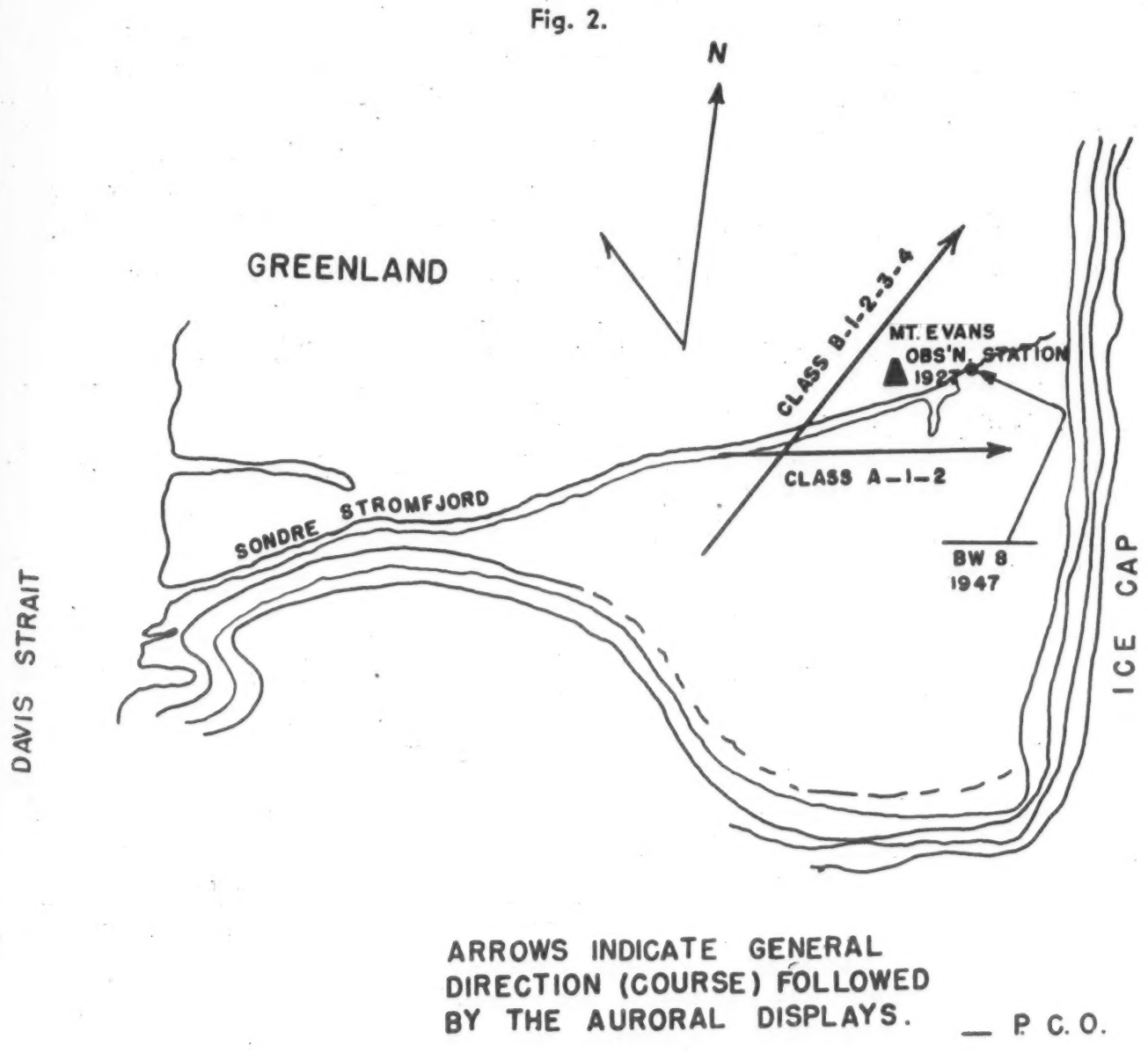
The magnetic field about the earth. One theory has it that the schematic entrapment in polar regions of solar electrified particles produces polar lights. Supporters of this theory point out the coincidence of auroral displays following the eruptions on the sun which we see as "sunspots."

Bearing the foregoing in mind, some connection can be evolved between the auroral corona and the "blanket effect" (obscuration of signals) sometimes noted in the Arctic.

There appears to be a form of disturbance of that part of the atmosphere of the earth, more readily classifiable as the radiosphere,[2] responsible for the occasional night or even short series of nights when no short-waves can be heard. During such a period one may maintain a tedious watch for hours at a time and find that only occasional "peeps" will struggle through from even the strongest stations. The auroral displays during those "blanket effects" observed were not particularly remarkable either as to class or types of radio influence. Ship stations and the other longer wave stations came through with normal clarity and volume, and until we became aware of the peculiarities of this "blanket effect" we spent a lot of time searching for the trouble in our short-wave receivers.

Listening to the radio stations of the Hudson's Bay Ice Patrol and also the signals of the schooner *Morrissey*, while in Hudson's Bay, indicated that radiospheric disturbances moved eastward and could be expected about 24 hours later, in most cases. We could not find any definite connection be-

Fig. 2.



ARROWS INDICATE GENERAL DIRECTION (COURSE) FOLLOWED BY THE AURORAL DISPLAYS. — P. C. O.

Photographs of aurora forms: Top—curtain, and weak streamers. Bottom—concentric curtains, arch, and corona. The white dots are stars. The vessel, lower center, is the "Maude" of Amundsen's expedition.

tween these radiospheric and coincident atmospheric disturbances. Agitations of the radiosphere due to storms would account only in part for the occurrences noted.

Direct reference to the station log has been avoided, because it is desired to prevent emphasizing any one observation and to facilitate the general statements which may only be made when there is a relatively large amount of data to work from.

Persons concerned with radio traffic transmission and reception will appreciate that expeditionary results are often of interest only to those who expect to revisit the spot explored or its neighborhood. However, in this case, the author wishes to point out a difference. Greenland lies directly within the great circle path between the middle western United States and Northern Europe. The logical line of flight is along the great circle and we already know that radio signals follow such a path in their travels. Therefore, these observations have tangible value to anyone about to transmit signals across the arctic or about to fly across and depend in any way upon radio transmission or reception.

The opportunities for further investigation along these lines and into all the other possible Arctic conditions which might affect radio transmission and reception are now greater than they have ever been before. There is an increasing number of stations now so scattered as to give adequate coverage over the Arctic portion of the Western Hemisphere and it should be possible to produce results as never before.

Among the many questions which can and should be answered are whether the conditions reported here are peculiar to the Greenland-Iceland area alone. The great disadvantage of using the observations of one station alone is that there is no comparable station which is capable of furnishing observations which act as a check on the first. Are these aurora phenomena local in character? What happens to the ionosphere when aurora passes. Does it make a difference as to which part of the Arctic one is in? Do Loran signals get deflected? Obscured? They probably do, but is the condition predictable as to degree and time?

Undoubtedly the answers to some of these questions and others not listed here are military secrets, but now that it is possible to carry out extensive investigations over considerable period of time it should be possible to add a great deal to our knowledge of the Arctic. One thing is certain. The Arctic radio operator or communicator must know long wave, medium wave and short wave equipment and principles as well as equipment if he wants to have the most constant communications possible under widely varying conditions.

This is not the place to set up plans and programs but the author would be very glad to assist in such work in any way possible. Because of natural limitations it is often necessary to prepare months in advance for some very simple experiment or test and, therefore, patience will be a necessary part of every plan.

FUNDAMENTAL LIMITATIONS OF SMALL ANTENNAS*

HAROLD A. WHEELER†

FELLOW, I.R.E.

Summary — **A capacitor or inductor operating as a small antenna is theoretically capable of intercepting a certain amount of power, independent of its size, on the assumption of tuning without circuit loss. The practical efficiency relative to this ideal is limited by the "radiation power factor" of the antenna as compared with the power factor and bandwidth of the antenna tuning. The radiation power factor of either kind of antenna is somewhat greater than**

$$\frac{1}{6\pi}\,\frac{Ab}{l^3}$$

in which *Ab* is the cylindrical volume occupied by the antenna, and *l* is the radianlength (defined as $1/2\pi$ wavelength) at the operating frequency. The efficiency is further limited by the closeness of coupling of the antenna with its tuner. Other simple formulas are given for the more fundamental properties of small antennas and their behavior in a simple circuit. Examples for 1-Mc. operation in typical circuits indicate a loss of about 35 db for the I.R.E. standard capacitive antenna, 43 db for a large loop occupying a volume of 1 meter square by 0.5 meter axial length, and 64 db for a loop of 1/5 these dimensions.

I. Introduction

AN ANTENNA whose dimensions are much less than the wavelength is subject to limitations which can be expressed by simple formulas. These limitations are fundamentally about the same for a capacitor used as an electric dipole and an inductor (loop) used as a magnetic dipole, if they occupy equal volumes. Either type may have some advantages resulting from variations within this rule or from relative facility in coupling with the associated circuits. This paper is directed to a few of the simplest formulas, and to their significance and application rather than their derivation. The small antenna to be considered is one whose maximum dimension is less than the "radian-length." The radianlength is $1/2\pi$ wavelength; it proves to be a logical unit for this purpose and a convenient one for simplifying the concepts and formulas. The approximations involved within this size depend only on the closeness between an angle and its sine up to ½ radian (4 per cent error). An antenna within this limit of size can be made to behave essentially as lumped capacitance or inductance, so this property is assumed.

It has occasionally been pointed out that a small antenna free of dissipation could take from a radio wave and deliver to a load an amount of power independent of the size of the antenna. This would be true at one frequency if the antenna can be resonated at that frequency without adding dissipation. It results from the fact that a smaller antenna delivers its lesser voltage from a lesser resistance such that the available power remains the same.

The power available from such an antenna is the wave power which would pass through the "effective area" of the antenna. Its effective area is 3/2 the area of a circle whose radius is one radianlength, denoted a "radian circle." The factor 3/2 is the power ratio of the directive gain of a small antenna relative to a theoretical antenna conceived to radiate equally in all directions over the sphere, denoted an "isotropic" antenna. This factor results from the fact that a

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Courtesy: Proceedings of the I.R.E.; The Institute of Radio Engineers, Inc.

small dipole (electric or magnetic) radiates in a doughnut pattern which effectively fills only 2/3 of the entire solid angle of a sphere.

Formulas for the efficiency of transmission through space may be stated in terms of the power actually radiated from the transmitting antenna and the power theoretically available from the receiving antenna to a load. In each case, the unavoidable dissipation in the coupling circuit (from generator to antenna or from antenna to load) limits the output to only a fraction of the power input. This fraction is the efficiency of the coupling circuit.

While the radiation pattern and hence the directive gain of a small antenna remain the same for a smaller size, the radiation resistance decreases relative to the other resistance in the coupling circuit. The resulting reduction in coupling efficiency is one of the principal limitations of the smaller antenna.

Another aspect of the same limitation relates to the frequency bandwidth of operation with fixed values of the circuit elements. A smaller antenna with the same reactance

II. Symbols

a = radius of circular cylindrical volume (meters)
A = area of base of cylindrical volume (meters^2)
b = height of cylindrical volume (meters)
n = number of turns of coil
k_a = shape factor of capacitor = effective area/actual area (A)
k_b = shape factor of inductor = effective length/actual length (b)
C = capacitance of antenna (farads)
L = inductance of antenna (henries)
ω = radian frequency (radians/second)
λ = wavelength (meters)
$l = \lambda/2\pi$ = radianlength (meters)
ϵ = electric permittivity in free space (farads/meter)
μ = magnetic permeability in free space (henries/meter)
k_e = relative permittivity of core in capacitor
k_m = relative permeability of core in inductor
$R = 120\pi = 377$ = wave resistance in free space (ohms)
$G = 1/R$ = wave conductance in free space (mhos)
R_e, R_m = radiation resistance in series with antenna (ohms)
G_e, G_m = radiation conductance in parallel with antenna (mhos)
R_t, G_t = series resistance or shunt conductance in tuner (ohms, mhos)
C_t, L_t = shunt capacitance or series inductance in tuner (farads, henries)
p_e = radiation power factor of capacitor antenna (electric dipole)
p_m = radiation power factor of inductor antenna (magnetic dipole)
k_c = coefficient of coupling between antenna and total capacitance
k_i = coefficient of coupling between antenna and total inductance
k_c^2 = efficiency of coupling of antenna to total capacitance = electric energy in antenna/total electric energy in tuned circuit
k_i^2 = efficiency of coupling of antenna to total inductance = magnetic energy in antenna/total magnetic energy in tuned circuit
e = radiation efficiency of antenna circuit.

III. Formulas

(*C*) (*L*)

Capacitance and inductance:

$$C = \epsilon \frac{k_a A}{b}; \qquad L = \mu n^2 \frac{A}{k_b b}. \tag{1}$$

Susceptance and reactance:

$$\omega C = G \frac{k_a A}{bl}; \qquad \omega L = R n^2 \frac{A}{k_b bl}. \tag{2}$$

Radiation shunt conductance and series resistance:

$$G_e = \frac{G}{6\pi}\left(\frac{k_a A}{l^2}\right)^2; \qquad R_m = \frac{R}{6\pi}\left(\frac{nA}{l^2}\right)^2 = 20\left(\frac{nA}{l^2}\right)^2 \tag{3}$$

$$R_e = \frac{R}{6\pi}\left(\frac{b}{l}\right)^2 = 20\left(\frac{b}{l}\right)^2; \; G_m = \frac{G}{6\pi n^2}\left(\frac{k_b b}{l}\right)^2. \tag{4}$$

Radiation power factor:

$$p_e = \frac{G_e}{\omega C} = \frac{1}{6\pi}\frac{k_a A b}{l^3}; \qquad p_m = \frac{R_m}{\omega L} = \frac{1}{6\pi}\frac{k_b A b}{l^3}. \tag{5}$$

Coupling efficiency, connected as in Fig. 2:

$$k_c^2 = \frac{C}{C + C_t}; \qquad k_i^2 = \frac{L}{L + L_t}. \tag{6}$$

Circuit efficiency, connected as in Fig. 2:

$$e = \frac{G_e}{G_e + G_t}; \qquad e = \frac{R_m}{R_m + R_t}. \tag{7}$$

Circuit efficiency, in general:

$$e = \frac{k_c^2 p_e}{k_c^2 p_e + p_t}; \qquad e = \frac{k_i^2 p_m}{k_i^2 p_m + p_t}. \tag{8}$$

IV. The Antenna

Fig. 1 shows two antennas occupying volumes alike in shape and size, one being a capacitor (*C*) and the

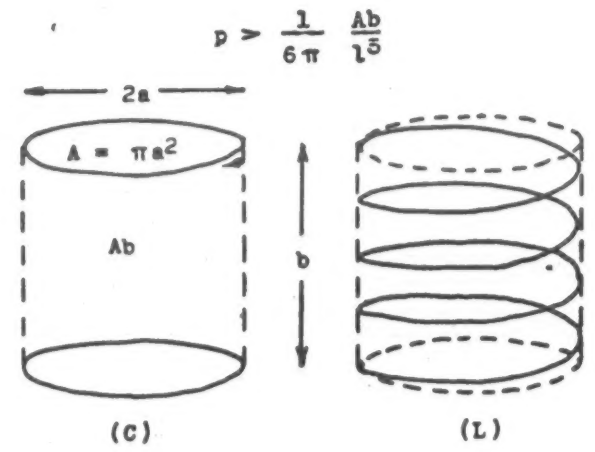

Fig. 1—Capacitor (*C*) and inductor (*L*) occupying equal cylindrical volumes.

and radiation resistance must be more sharply tuned to

ver its available power. Therefore, the reduction of size poses a fundamental limitation on the bandwidth. If the dwidth so limited is insufficient, further damping must added at the expense of coupling efficiency.

The limitations verify the experience that larger antennas generally more efficient, especially for wide-band operation.

By expressing the formulas in fundamental forms, the inherent similarity of the electric and magnetic radiators becomes apparent, as well as the minor differences resulting from the use of available materials and structures.

other an inductor (L). Their maximum dimensions are less than the radianlength of operation. Their shapes are cylindrical because that is the only shape that can alternatively be occupied by either a capacitor or an inductor. The volume may be bounded by a circular cylinder, as shown, or by other cylinders such as square or rectangular.

In both cases, the antenna is assumed to operate as a lumped circuit element of the kind indicated (C or L), neglecting distributed properties. The inductor (loop antenna) is assumed to act as a current sheet pervious to alternating magnetic flux, as is customary in the theory of solenoidal coils: this assumption is justified if the coil is wound of several turns of wire or ribbon having a width of about ½ the pitch of winding.

The symbols and principal formulas are tabulated above for convenience. All formulas have the same form for the two kinds of antennas, except for the number of turns n and the correction factors k_a and k_b. These factors are defined to have such values that (1) gives the correct values of C and L.

For the capacitor, the correction factor k_a multiplies the area A to obtain the effective area, as augmented by the electric field outside the cylindrical volume. This factor is greater than unity and (for circular disks, $A=\pi a^2$) greater than

$$\frac{4}{\pi}\frac{b}{a} = 1.27\frac{b}{a}, \qquad (9)$$

based on two disks far apart. The value of k_a is asymptotic to unity for $b \ll a$, and is asymptotic to (9) for $b \gg a$.

For the inductor, the correction factor k_b multiplies the axial length b to obtain the effective length of the magnetic path as augmented by the external return path. This factor also is greater than unity. If $b>a$ for a circular coil ($A=\pi a^2$), this factor is closely approximated by the asymptotic value:

$$k_b = 1 + \frac{8}{3\pi}\frac{a}{b}; \quad \text{or better,} \quad k_b = 1 + 0.9\frac{a}{b}. \qquad (10)$$

The effective volume becomes

$$k_b Ab = Ab + 0.9aA = Ab + 2.8a^3. \qquad (11)$$

If $b<a$, the factor is somewhat less than this value.

The electric-dipole radiation from the capacitor is represented by shunt conductance G_e or series resistance R_e. The magnetic-dipole radiation from the inductor is represented by series resistance R_m or shunt conductance G_m. In both kinds of antenna the resistance formula is free of the correction factor, because the radiation is caused by the current which is confined to certain definite dimensions of the structure. Therefore, the radiation resistance is the concept ordinarily used. Its value is given not only in the general form but also in the simplified form valid in free space.

The fundamental limitation on the bandwidth and the practical efficiency of a small antenna is the radiation power factor, p_e or p_m, given by (5). It is always much less than unity because of the small size. It has the same value, whether computed from radiation resistance or conductance. It has the same form for both kinds of antennas. Its value, except for the correction factor, is the same for both kinds, and depends only on the ratio of the antenna volume Ab to the radian cube l_r.

In (5) the coefficient $1/6\pi$ is the product of the two factors $1/4\pi$ and $2/3$. The former is the reciprocal of the solid angle of a sphere, which appears in rationalized formulas involving spherical waves. The latter is the fraction of the sphere which is filled with the doughnut pattern of radiation characteristic of a small dipole.

As a special case of the radiation power factor, consider an antenna occupying a cubic space Ab equal to a radian cube l^3. The resulting power factor is $1/6\pi=0.053$, multiplied by the correction factor. In this case, approximately, $k_a=2.7$ and $k_b=1.5$, so the power factors are $p_e=0.14$ and $p_m=0.08$. Therefore, this size of antenna has sufficient radiation damping to operate over a bandwidth of the order of 1/10 the mean frequency, even if there is no other damping.

A cubic antenna of this size (and one turn on the inductor) has a reactance comparable with the wave resistance of the medium ($R=1/G=120\pi=377$ ohms in free space). The reactance ($1/\omega C$ or ωL) of each kind is reduced by the correction factor, so it has a value of 140 ohms for the capacitor, or 250 ohms for the inductor. Reducing the size or the frequency increases the reactance of the capacitor and reduces that of the inductor. The latter has greater flexibility in that its reactance can be increased with the number of turns.

In the cubic shape, the correction factor is slightly greater for the capacitor than for the inductor. This advantage is real, though it is small and may be overbalanced, in some cases, by circuit disadvantages.

If the axis of the cylinder is vertical, either antenna radiates in a pattern like a horizontal doughnut. Since the polarization is expressed with reference to the electric field, the capacitor radiates with vertical polarization and the inductor with horizontal. The required polarization is likely to be the determining factor in choosing which kind to use, if the horizontal doughnut is the desired pattern of radiation.

A plane reflector doubles the radiation power factor if it is located close enough to either kind of antenna and in such relation as to re-enforce the radiation. The plane reflector acts by virtue of its great conductivity or relative permittivity. A surface of water or ground may approximate a plane reflector. The size of the antenna and its proximity to the reflector must be such that the antenna and its image fall within a maximum dimension less than the radianlength, if the radiation power factor of (5) is to be doubled. Also, the reflector must have a radius greater than 1/4 wavelength. To re-enforce the radiation, the plane must be perpendicular to the axis of the capacitor or parallel to the axis of the inductor, so the polarization is perpendicular to the plane.

The cylindrical volume may be filled with a dielectric core in the capacitor or a magnetic core in the inductor. In either case, the radiation shunt conductance (not the series resistance) remains the same, because it is determined by the energy in the field outside of the antenna, regardless of that inside. A dielectric core of relative permittivity k_e increases the capacitance to

$$C = \epsilon \frac{A}{b}(k_a + k_e - 1) \qquad (12)$$

approximately if $b<2a$. This reduces the radiation power factor in the ratio

$$\frac{k_a}{k_a + k_e - 1} = \frac{1}{1 + \dfrac{k_e - 1}{k_a}}. \qquad (13)$$

A magnetic core of relative permeability k_m increases the inductance to

$$L = \mu n^2 \frac{A}{b(k_b + 1/k_m - 1)} \qquad (14)$$

approximately if $b>2a$. This increases the radiation power factor in the ratio

$$\frac{1}{1 - \dfrac{k_m - 1}{k_m k_b}} = \frac{1 + 0.9\dfrac{a}{b}}{\dfrac{1}{k_m} + 0.9\dfrac{a}{b}}. \qquad (15)$$

The efficiency may be further increased by reduction in the effective coil resistance.

The structure of the antenna is a subject by itself, outside the scope of this monograph.

The same principles may be applied to the design of a reactor in which radiation is undesired and low power factor ("high Q") is desired. If the reactor is unshielded, the optimum size is a compromise between larger size to reduce internal series resistance and smaller size to reduce internal shunt conductance and radiation. The optimum size for a single-layer coil with negligible dielectric power factor is that for which the radiation power factor is a minor fraction of the total, say between 1/6 and 1/2, depending on the nature of the factors which determine the internal resistance. In ordinary cases, the volume of the soil should not exceed about 1/100 of a radian cube, which means the diameter and length, if equal, should not exceed about 1/5 radianlength, or 1/30 wavelength. If this size is too small, a larger coil with shielding may be required.

V. The Circuits

Efficient operation of a small antenna requires tuning to the operating frequency with a circuit which offers little additional dissipation. How much the circuit may detract from the efficiency depends on the nature of the generator or load coupled therewith, and on other requirements such as bandwidth. The simplest case will be described as an example.

Fig. 2 shows a generator or load coupled with an antenna of either kind (C or L) through its tuner. In the case of a

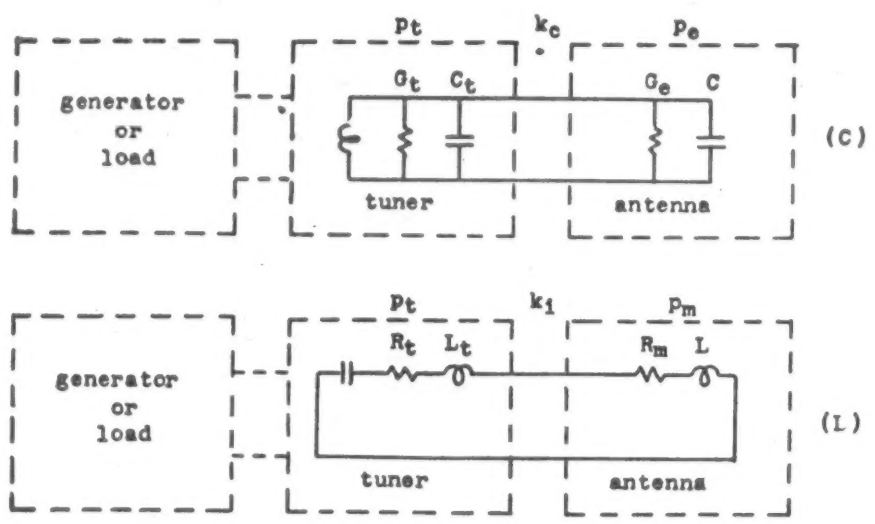

Fig. 2—Tuned coupling of antenna with generator or load.

generator, it is assumed that it is so coupled with the tuner as to deliver all of its available power to the tuner and antenna. In the case of a load, it is assumed that it is so coupled with the tuner as to receive the maximum power therefrom, which is called the "available power."

In general, the efficiency of the coupling circuit is increased by increasing the coefficient of coupling between the tuner and the antenna, and by decreasing the power factor of the tuner.

The coefficient of coupling (k_c or k_i) between the tuner and the antenna is defined in the usual way. Its square is called the "coupling efficiency" because it denotes the fraction of the total electric or magnetic energy of the tuned circuit which is in the antenna. It is expressed in (6) for the simple connection of Fig. 2, but has more general significance.

The power factor p_t of the tuner is taken to include all dissipation in the tuner and antenna, except the desired radiation. In Fig. 2, this is lumped in the effective shunt conductance G_t or the effective series resistance R_t. It is connected directly in parallel or in series with the radiation effective conductance G_e or resistance R_m. In this connection the circuit efficiency is merely the ratio of the radiation power to the total power in the circuit, as expressed in (7).

The more general expression of circuit efficiency is given by (8), in terms of power factor and coupling efficiency. This gives an indication of the relative importance of all factors.

After the coupling circuit has been designed for the maximum efficiency at the frequency of resonance, consistent with available space, materials, and precision, the total power factor of the circuit will exceed $k_c^2 p_e$ or $k_i^2 p_m$ by the amount of the tuner power factor p_t and the added power factor contributed by the generator or load. If the antenna comprises all the reactance of one kind in the circuit, and the tuner losses are small, the total power factor of the circuit may be that of the antenna plus an equal value coupled from the generator or load. Therefore, a very efficient design may have a loaded power factor $2p_e$ or $2p_m$, and a corresponding bandwidth of the tuned circuit.

If the bandwidth desired in the coupling circuit is either less or greater than that obtained by designing for maximum efficiency at the frequency of resonance, the redesign for different bandwidth will be at the expense of efficiency. Lesser bandwidth may be obtained by decreasing the coupling with generator or load, decreasing the coupling between tuner and antenna, multiple tuning, or decreasing the antenna size. Greater bandwidth may be obtained by increasing the coupling with generator or load, increasing the power factor of the tuner, or developing the tuner into a wideband circuit.

Some types of generator or load do not double the power factor of the tuned circuit when coupled for normal operation. An efficiency generator, for example, operates best into an impedance much different from its internal impedance. A current generator of high resistance, such as a high-μ screen-grid tube, contributes little damping to a tuned output circuit. On the other hand, a voltage generator of low resistance, such as a low-μ triode tube or cathode-output circuit, more than doubles the damping in a tuned output circuit. Likewise, there are load circuits which are essentially voltage-operated, such as a voltmeter or the grid circuit of an amplifier; or current-operated, such as an ammeter. Either type of load may not be designed to utilize the available power, in which case it may add little to the damping. In view of the various effects of the associated circuits, the radiation power factor of the antenna is not the ultimate limitation on the bandwidth of efficient operation, but does

dicate the order of magnitude and the trends with changes in antenna design.

VI. Examples

First example: A loop antenna is intended for operation with horizontal axis in a radio receiver cabinet in a small frame building. Its size is 1 meter square by 0.5 meter axial length.

Wavelength:	$\lambda =$	300	m. (at 1 Mc.)
Radianlength:	$l =$	48	m.
Radian cube:	$l^3 =$	110,000	m.^{3}
Antenna volume:	$Ab =$	0.5	m.^{3}
Shape factor:	$k_b =$	2	

The radiation power factor is computed by doubling (5) to include approximately the effect of the ground plane.

Radiation power factor: $p_m = 0.96 \times 10^{-6}$.

Radiation power factor: $p_m = 0.96 \times 10^{-6}$.

The loop is assumed to be one-half the entire inductance of the tuned circuit (6).

Coupling efficiency: $k_i^2 = 0.5$.

The power factor of the entire tuned circuit is assumed to be 0.01 and the efficiency is computed from (8).

Efficiency: $e = 0.48 \times 10^{-6} / 0.01 = 0.048 \times 10^{-3}$.

This represents a loss of 43 db. It is noted that the essential performance is obtained without reference to incidental factors, such as the number of turns, which are supplied by ordinary design procedure.

A capacitive antenna of comparable volume would give comparable performance, with some practical advantages and disadvantages. Its disuse indicates that the disadvantages usually predominate.

A loop antenna as small as 1/5 the dimensions of this example, namely, $0.2 \times 0.2 \times 0.1$ meter, is used in small receivers. The efficiency is approximately 0.4×10^{-6}, representing a loss of 64 db at 1 Mc.

Second example: A capacitive antenna over ground is connected with a radio receiver. The antenna is a wire so its area is undefined. Including lead-in, its effective height is 4 meters and its capacitance is 200 micro-microfarads, the I.R.E. standard. Therefore, its effective area is determined by (1).

Antenna capacitance:	$C =$	200 $\mu\mu$fd.
Effective height:	$b =$	4 m.
Effective area:	$k_a A = bC/\epsilon =$	90 m.^{2}
Effective volume:	$k_a Ab =$	360 m.^{3}
Wavelength:	$\lambda =$	300 m. (at 1 Mc.)
Radianlength:	$l =$	48 m.
Radian cube:	$l^3 =$	110,000 m.^{3}

The radiation power factor over the ground plane is computed by doubling (5).

Radiation power factor: $p_e = 0.35 \times 10^{-3}$.

The coupling efficiency is assumed to be reduced to about 0.01 so large variations of antenna will not cause appreciable detuning of the circuit.

Coupling efficiency: $k_c = 0.01$.

The power factor of the entire tuned circuit is assumed to be 0.01 and the efficiency is computed from (8).

Efficiency: $e = 0.35 \times 10^{-3}$.

This is a loss of 35 db, chargeable 15 db to circuit dissipation and 20 db to decoupling for reducing the reaction of antenna changes on the tuning. Part of the latter (20 db) can be recovered by greater coupling and providing for retuning on each antenna. Otherwise, it is noted that this antenna is only 8 db better than the loop antenna of the first example.

Third example: A loop antenna is intended for operation with vertical axis in a television receiver cabinet. Its size is 0.5 meter cube. It is tuned to the desired frequency channel.

Wavelength:	$\lambda = 5$	m. (at 60 Mc.)
Radianlength:	$l = 0.8$	m.
Radian cube:	$l^3 = 0.51$	m.^{3}
Antenna volume:	$Ab = 0.12$	m.^{3}
Shape factor:	$k_b = 1.5$	
Radiation power factor:	$p_m = 0.019$.	

Since the required bandwidth is about 0.1 of the center frequency, or about $5p_m$, there is a loss of only 4 to 7 db, depending on the nature of the circuits connected with the antenna for increasing the bandwidth.

Fourth example: A loop antenna is intended for operation with horizontal axis in a portable f.m. receiver. Its size is 0.2 meter cube. It is tuned to the desired frequency. All losses except radiation and load are assumed to yield a tuner power factor of 0.01.

Wavelength:	$\lambda = 3$	m. (at 100 Mc.)
Radianlength:	$l = 0.48$	m.
Radian cube:	$l^3 = 0.11$	m.^{3}
Antenna volume:	$A_b = 0.008$	m.^{3}
Shape factor:	$k_b = 1.5$	
Radiation power factor:	$p_m = 0.0058$	
Tuner power factor:	$p_t = 0.01$	
Efficiency:	$e = 0.37$.	

This is a circuit loss of 4 db. The bandwidth is 2 or 3 Mc., more than enough for a single channel 0.2 Mc. wide. However, if the same antenna were required to cover the entire band of 88 to 108 Mc. without retuning, a width of 0.2 times the mean frequency, the loss would be 12 to 15 db caused by the wide-band circuit.

Bibliography

(1) E. B. Rosa and F. W. Grover, "Formulas and tables for the calculation of mutual and self-inductance," *Sci. Papers, Bur. of Stand.*, No. 169, p. 121, formula 79 (the end correction for a solenoid); December 18, 1916.

(2) J. H. Jeans, "Electricity and Magnetism," p. 249 (capacitance of disk), Cambridge University Press, London; 1925.

(3) H. A. Wheeler, "Simple inductance formulas for radio coils," Proc. I.R.E., vol. 16, pp. 1398-1400; (end correction for a solenoid); October, 1928.

(4) C. R. Burrows, "Radio propagation over plane earth," *Bell Sys. Tech. Jour.*, vol. 16, pp. 45-74; (Introduction, transmission efficiency in space); January, 1937.

(5) Simon Ramo and J. R. Whinnery, "Fields and Waves in Modern Radio," pp. 432, 458 (radiation resistance of small electric dipole and loop); John Wiley & Sons, Inc., New York, N. Y.; 1944.

(6) H. T. Friis, "Simple transmission formula," Proc. I.R.E., vol. 34, pp. 254-256 (transmission efficiency in space, expressed in terms of effective area); May, 1946.

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ANNUAL CONVENTION, MAY 10, 11, DAYTON & WRIGHT FIELD, OHIO

Last year our first annual convention was held at New York and Fort Monmouth. The exhibition and demonstration at Monmouth featured ground force communications and photographic equipment and techniques. About 700 of our members were present. This year hundreds of our members from all parts of the U. S. and especially from the middle west are expected to attend this year's meeting which will feature Air Force equipment and techniques. The banquet at 7:15 P.M., May 10, in the Dayton-Biltmore Hotel is being arranged by the Dayton chapter. Tickets are $11.00 for cocktail party, banquet, "brunch" at the Biltmore May 11 and transportation from Dayton to Wright Field and return. The application blank elsewhere on this page should be completed at once and mailed with remittance to Chairman, Committee on Arrangements, Mr. Philip H. Johnson, P.O. Box 2, Dayton View Branch, Dayton, Ohio, or to National Headquarters. The Honorable Stuart W. Symington, Secretary of the Air Force and Mr. Thomas J. Hargrave, Chairman of the Munitions Board, will be the principal speakers at the banquet. The hotel situation at Dayton is likely to be acute so you should arrange for reservations NOW. The Dayton chapter will assist you if you so request. Details of the program both at Dayton and at Wright Field the next day have already been sent to all members by special bulletin. There will be many spectacular features in connection with the Wright Field demonstration—both in Air Force communications and photography and in combat flying. These will include the "push button" C-54 which recently flew the Atlantic unassisted and an air show of the latest jet aircraft as well as some features not to be announced until the day of the meeting. No one interested in post war advances in Air Force techniques can afford to miss this unique meeting. Dinner applications must be in the hands of the Dayton committee by April 20th.

Election of National Directors

When the association's name was changed two additional directors—Commodore Jennings B. Dow, and former FCC member E. K. Jett were elected by the directors to serve until the regular election by the Council at the convention in May. Both of these directors had been associated for many years with Navy communications. Previously Brig. Gen. S. H. Sherrill had been named by the board as an interim director so he, as Executive Secretary, might vote on policies discussed at Executive Committee and Directors meetings. These

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Date .....

Please reserve following at $11.00 each: (Ticket admits to all events)

No.	Time	Event
.....	7:15 P.M.	Banquet, May 10th
.....	9:30 A.M.	Business Meeting, May 11th
.....	11:00 A.M.	Luncheon, Biltmore, May 11th

I will arrive at ..... M., May ..... by .....

I am enclosing check for $ ..... to cover the above, which does not include hotel reservations, which I will arrange for.

Name .....

Address .....

th e directors or other members to su eed them will be selected by the C ncil in the manner prescribed in th constitution, at the May 10th m ting.

At a recent conference with the chairman of the Munitions Board, Mr. Thomas J. Hargrave, and members of his staff, including Mr. Stuart Cramer, Mr. Robert Applegate, Maj. Gen. Sidney P. Spalding and Lt. Col. William F. Starr, the Executive Secretary again emphasized the readiness of Armed Forces Communications Association to assist in any way desired in Industrial Mobilization problems. The Chief of Ordnance stated recently that the Ordnance Department will keep industry informed through the American Ordnance Association and that the association will be the liaison to tell manufacturers of Ordnance's plans for production. Armed Forces Communications Association invites the Armed forces to consider using our association to whatever extent considered desirable in the same manner.

National HQ's New Address

Our offices were moved last month to somewhat more spacious rooms in the old Army-Navy Club at 1624 "I" Street at Connecticut Avenue, N.W.—directly across "I" Street from the present Club. The building has an interesting history. It was the first Army-Navy Club building in Washington and was used until the present club building was constructed in 1912. The first president was Lieutenant General John M. Schofield, famous Civil War commander and later Secretary of War. Our members are invited to stop in and see us. Out-of-town members may find it convenient to use our office for their local address when in Washington.

Two Stars for Air Communications Officer

Communications in the Air Force has been recognized again as an essential to modern warfare and air operations by the recent action in placing the Air Communications Officer on a higher level at USAF Headquarters in Washington and the promotion of F. L. Ankenbrandt, at present Air Communications Officer, from Brigadier General to Major General. Elsewhere in these pages details of this change are described. It is gratifying to see this step taken as it is one of Armed Forces Communications Association's objectives to help ensure that due consideration is always given to the complicated nature of modern communications and their use by the Armed Forces.

The Air Force and the Armed Forces Communications Assoc.

"SUBJECT: Armed Forces Communications Assoc.

"To: Commanding Generals, Major Air Commands

1. There has been organized the 'Armed Forces Communications Association'. The stated purposes of this association are:

a. The maintenance of closer relations than ever before between civilian scientists and engineers and manufacturing and operating companies of the communication industry and similar activities in armed services communications and radar.
b. The education of the public at large and the association members on requirements in the field of military communications.
c. The maintenance of efficient personnel, commissioned enlisted, and civilian, for the supply (including design and development), installation, maintenance, and operation of communications and electronic equipment for the armed services in peace as well as in war.

"The Air Force is in agreement with these stated purposes and with the establishment of the 'Armed Forces Communication' for the accomplishment of these purposes.

"Any one desiring any information concerning the association can obtain it from the Executive Secretary, Armed Forces Communications Association, 1624 "I" Street, N.W., Washington 6, D. C.

"It is requested that the provisions of this letter be brought to the attention of all concerned so that all individuals and organizations who desire to do so may participate and thereby ultimately assist the Air Force in the electronics field."

BY COMMAND OF THE CHIEF OF STAFF:

H. G. CULTON
Colonel, USAF
Air Adjutant General

Engineers' Annual Meeting

The 28th Annual Meeting of the Society of American Military Engineers will be held at Fort Belvoir, Virginia, on Friday May 7, 1948.

The Engineer Center, the Engineer Research and Development Laboratories are putting on what should prove to be an interesting demonstration and exhibition for The Society.

The members of Armed Forces Communications Association are invited to attend.

Chartered busses (round-trip fare $1.00) will leave from the Mills Building at 9:00 A.M., will take visitors to each demonstration area within Fort Belvoir and will leave for the return trip at 4:30 P.M. Lunch will be available. Those who desire to use bus transportation call (ME. 2772) or write Society of American Military Engineers, Mills Building, 17th and Pennsylvania Ave., N.W., Washington, D. C.

Signal Corps Day

Many chapters held special meetings on March 3rd commemorating the 85th Anniversary of the founding of the Signal Corps. The guest of honor and principal speaker at the Washington chapter meeting was the Secretary of the Army, The Honorable Kenneth C. Royall.

American Standards Association

Colonel Louis J. Tatom, Commanding Officer of the Army Electronics Standards Agency, Fort Monmouth, New Jersey was recently elected to the Executive Committee of the American Standards Association—a federation of National groups dealing with standardization, through which Government, industry, labor and the consumer work together to develop mutual satisfactory national standards, the American cooperation in standardization work.

Technical Specialty

National Headquarters is preparing a file of members arranged according to their communications or photographic specialty, if any. Please drop us a postcard listing your specialty, thus assisting in our compilation of these data for possible emergency use.

Largest Chapters

The three largest chapter are Far East (Japan), New York and Fort Monmouth. Most noteworthy is the growth of the Far East chapter which was not chartered unitl December 5, 1947 as Chapter #18. Brigadier General G. I. Back, chapter president and his energetic membership committee, are to be commended for their fine progress which they state will continue with many Navy and Air Force military and civilian personnel soon to join. All this does not mean there is no chance for other chapters winning the distinction of being the first annual honor chapter, the rules for which are outlined in January-February SIGNALS. Other chapters, especially small ones, might take a leaf from the book of the QM Asso-

CHAPTERS AND SECRETARIES

ATLANTA: Maj. Peter J. Ryan, Hqs. 3rd Army, Ft. McPherson, Ga.

BALTIMORE: Col. Arthur Pulsifer, Sig. Sec., Hq. 2nd Army, Ft. Meade, Md.

BOSTON: Capt. F. P. Singleton, Boston Army Base, Boston 10, Mass.

CHICAGO: Col. Raymond K. Fried, 111 W. Monroe St., Chicago 3, Ill.

CLEVELAND: C. L. Haas, 2814 Hampton Road, Rocky River 16, Ohio.

DALLAS: E. H. Mittanck

DAYTON: Gertrude A. Knight, 54 Patterson Village Dr., Dayton, Ohio.

DECATUR: E. C. Whitcomb, RR 6, Box 263, Decatur, Ill.

EUROPEAN: Lt. W. G. Hall, Comm. Center, OCSIGO, Hq. Sig. Off., APO 757, c/o PM, New York, N. Y.

FAR EAST: Miss Helen M. Reynolds, Sig. Sec., GHQ., FEC, APO 500, c/o PM, San Francisco, Calif.

FORT MONMOUTH: Col. William L. Seibert, Squier Signal Laboratory, Fort Monmouth, N. J.

KENTUCKY: Capt. John A. Short, Lexington Signal Depot, Lexington, Ky.

NEW YORK: Lt. Col. Frank H. Fay, 32 Avenue of the Americas, New York, N. Y.

OGDEN-SALT LAKE: Miss Marjorie Hansen, 2227 Adams Ave, Ogden, Utah.

PHILADELPHIA: Joseph Bergman, Sig. Corps Stock Control Agency, 2800 So. 20th St., Philadelphia, Pa.

PITTSBURGH: Capt. J. J. McGovern, Bell Telephone Co., 229 Spahr St., Pittsburgh 6, Pa.

RICHMOND: Miss Jean Melton, Ches. & Potomac Tel. Co., 703 E. Grace St., Richmond, Va.

RIO: Maj. Huston Maxwell, JBUSMC, APO 676, % Pm, Miami, Fla.

SACRAMENTO: Lt. Col. George H. Melvin, Jr., Sacramento Signal Depot, Sacramento, Calif.

ST. LOUIS: Capt. Henry C. Hughes, 319 No. 4th St., St. Louis 2, Mo.

SEATTLE: Capt. Lawrence W. Bucy, Alaska Communication System, Seattle 4, Wash.

WASHINGTON: Col. Edward C. Cover, Chesapeake & Potomac Tel. Co., 725 - 13th Street, N. W., Washington, D. C.

STUDENT CHAPTERS

CORNELL: John M. Ross, 126 McFaddin Hall, Ithaca, N. Y.

NEW YORK UNIVERSITY: Robert D. Hawkins, 26 Spruce Ave., Ridgefield, N. J.

OKLAHOMA A & M: W. L. Covel, Mil. Dept., Okla. A & M College, Stillwater, Okla.

TEXAS TECH: T. L. Timmons, 2012 8th Street, Lubbock, Texas.

UNIVERSITY OF CALIFORNIA: R. G. Barhite, Bowles Hall, U. of Calif., Berkeley, Calif.

All members of the Association who are not members of local chapters, and who live at places where attendance at local chapter meetings is practicable, are urged to write to the secretary of the nearest Chapter and apply for membership. These Chapters are organized under individual constitutions and by-laws which authorize them to impose Chapter dues, to decide upon membership, and to set up requirements not inconsistent with the approved constitutions and by-laws. Chapter meetings at which military communications and photography subjects are discussed by well-informed speakers, or pertinent films shown, are held periodically. Programs for meetings are arranged by the officials of the Chapters.

It is desirable that new Chapters be organized in all places where they are likely to be strong and permanent, but not at places where they would be likely to become inactive soon.

Those chapters which charge local dues have set them at a modest amount.

ciation's San Antonio chapter which won their banner award for an increase in membership last year far in excess of 100%. Our competition ends on April 30, 1948.

Atlanta

The formal presentation ceremony of the charter for the Atlanta Chapter was held at the Officers' Club at Fort McPherson, Atlanta, on the evening of March 16th. The honor guests included representatives from the communications industry, the Georgia School of Technology, and the Army, Navy and Air Forces in the Atlanta area. More than 300 were present and heard brief addresses by General A. C. Gillem, Commanding General of the Third Army; Col. T. H. Maddocks, the acting president of the chapter; and the National Executive Secretary of AFCA, Brig. Gen. Sherrill, who came down from Washington to make the presentation. In his address, Gen. Sherrill stressed the increasingly critical world situation, quoting from remarks made by Gen. Marshall in his Washington Cathedral speech on March 11th, and urged renewed support by industry and civilians of AFCA and its principal objective of helping to improve communications and photography in all three armed forces.

Baltimore

Some 200 members met at a dinner meeting at the Lord Baltimore Hotel on March 16th to celebrate the first anniversary of the Baltimore Chapter. Lieut. General Leonard T. Gerow, Commanding General of the Second Army, was the guest speaker. His topic was "The Military in the Government", which was especially interesting because of its timeliness.

Chicago

The details of the plan mentioned in January-February SIGNALS as under study by the Chicago chapter have been presented to Army, Navy and Air Force planners for consideration and use if they so desire. It is entitled "A Plan to Provide Both Military and Industrial Interests With Engineering Skill for National Emergency Use." In the introduction it is stated that "as matters now stand, military authority must depend upon private enterprise for the bulk of the manpower to fill in many key Military Occupational Specialties, in case of an emergency, until a military program can be turning out technically trained men in large numbers.

"But if there were a means of assuring both the armed forces and the individual manufacturer of a definite number of acceptable men, each with a certified amount of knowledge and skill, the task of large scale mobilization would be immeasurably simplified and speeded up."

The report goes on to say that "The preparation of these men can start just as soon as military authorities provide curriculum to assure the level of convertible knowledge and skill desired, and distribute this curriculum to the private schools of America.

(Editors note: The term "private schools" as used here applies to such

establishments as Capitol Radio Engineering Institute, RCA Institutes, American Television, Inc., Tyler Commercial College some of which already are group members of AFCA.)

It is then stated that "private schools programs invariably include one or more borderline subjects. While these borderline subjects are related to the field taught by the school, they are not as important in the eyes of the administration as the rest of the curriculum. It is in this borderline area where subjects of military usefulness can be substituted by the private schools," and further that "while the students are receiving the training to enable them to convert to wartime functions without additional schooling, they can be carefully classified as to military or industrial fitness. A physical examination could quickly determine whether or not a man is suitable for active military service. Once his status is determined, his assignment in the case of war could be prearranged. Under this plan, the manufacturer will know in advance how many members of his technical staff can be depended upon for the duration in estimating on war contracts."

In conclusion the report states that the "plan will accomplish two objectives of major importance:

"1. Supply the armed forces with a ready source of manpower especially trained to be of immediate military usefulness in technical fields.

"2. Assure the manufacturing strength of our nation's industry and guarantee a rigid backbone of technical skill for wartime production.

"Furthermore, this plan can be put into effect in a very short space of time if action is taken at once.

"Huge sums of money that are already being expended at a rate of millions per day can get this job done without any significant additional expense whatsoever.

With the data assembled and forwarded to the Selective Service System by the personnel of the private schools, manpower allocations can be planned in advance with an absolute degree of certainty."

Cleveland

The Cleveland Chapter, as a unit, has become a member of the Cleveland Technical Societies Council. The Chapter is now one year old and currently has approximately 110 members. It serves primarily as a get-together point for the members located in the Northeastern part of the State of Ohio.

Chapter meetings usually are held on the 2nd Thursday of each month. At the March 11th meeting, the program was presented by the Cleveland District of the U. S. Coast Guard and concerned activities in the Great Lakes region, with emphasis on applications of electronic aids.

Dallas

Second Annual Industry-Army Day —Last year it was at Chicago and General Eisenhower the principal speaker. This year it was in Dallas, on January 23rd with General Bradley delivering the principal address before 900 industrialists from the entire U. S. at the Baker Hotel. The purpose of the meeting was to bring together the highest level leaders of the Army and the industralists who have indicated their interest in National Security and their desire to help where possible by joining one of the so-called military associations. Colonel H. L. Reynolds of our Dallas Chapter was our representative on the joint committee. He arranged and presided at a luncheon in honor of Major General Spencer B. Akin, Chief Signal Officer of the Army, attended by about 105 guests including most of the association members and many representatives of communications, photographic and electronics industries from that area. General Akin, who delivered the principal address at the luncheon, described the projects being undertaken by the Signal Corps in order to keep abreast of future types of warfare.

General Akin also brought out that the Armed Forces Communications Association and its members and chapters are of great importance to the Signal Corps and the National Defense Establishment's integrated program of national security. The Association, he said, was a primary link between the Signal Corps and the public in general and industry and he complimented the Association for establishing several committees to establish cooperation between it and the Signal Corps.

The newly elected officers of the Dallas Chapter are: Col. H. L. Reynolds, president; G. C. Buchanan, 1st vice-president; Col. L. B. Redmond, 2nd Vice-president; Maj. Warren S. Hatfield, 3rd vice-president; E. H. Mittanck, secretary; and Frank Parker, treasurer.

Dayton

On January 20th, members of AFCA in Dayton and Wright Field met in the auditorium of the Ohio Bell Telephone Company for the purpose of organizing a Dayton Chapter. Brig. Gen. S. H. Sherrill, Executive Secretary of the Association, attended the meeting and explained the purposes of the Association. The following interim officers were elected: Edward H. Bobzean, president; Winton O. Etz, vice-president; Gertrude A. Knight, secretary; and Philip H. Johnson, treasurer.

Chapter representatives are now actively engaged in making plans for the annual convention.

European

A meeting was held on March 6th in Frankfurt to reactivate this chapter. The new officers are: Mr. Loren Dean, president; and Lt. W. G. Hall, secretary.

Far East

The Far East Chapter assembled in Tokyo on March 3rd for the presentation of its charter and to commemorate the 85th anniversary of the Signal Corps. AFCA President David Sarnoff sent a congratulatory message to Brig. Gen. Back, Chapter president.

Fort Monmouth

Members and their guests met at a dinner meeting at Gibbs Hall, Fort Monmouth, on February 26th. Mr. R. A. Cushman, of the Bell Telephone Laboratories, spoke on "TDS"—Time Division Scrambling—which is a new crytographic means of radio and/or wire transmission. This was the first time that this subject had been discussed publicly.

The new officers for the current years are: Lt. Col. Charles S. Hays, president; Col. William L. Seibert, 1st vice-president and secretary-treasurer; and Mr. O. D. Perkins, 2nd vice-president. The chapter has launched a vigorous campaign to attract new members.

Richmond

The Richmond Chapter held its first meeting of the year on January 20th at the John Marshall Hotel. The subject of the evening was "Modern Communication Facilities as Applied to Railroad Operations" and was conducted by Mr. P. A. Flanagan of the Chesapeake and Ohio Railroad. Mr. Flanagan outlined the special problems involved in railroad communications and various solutions and experiments being worked out in this field. The subject proved most interesting to the group and evoked a lively response in questions and discussions.

A Navy technicolor film, "The Silent Service," depicting the role of the submarine in World War II, was shown at the close of the program.

The next meeting will be on March 30th. The speaker will be Mr. Louis

National Advisory Committee Chairmen

GENERAL MANUFACTURING: Mr. Fred R. Lack, V. Pres., Radio Division, Western Electric Company, New York City

BATTERY MANUFACTURING: Dr. George W. Vinal, Bureau of Standards, Washington, D. C.

DRY BATTERY SUBCOM.: Mr. Ralph E. Ramsay, V. Pres. & Research Director, Ray-O-Vac Company, Madison, Wisconsin

STORAGE BATTERY SUBCOM.: Mr. L. E. Wells, Chief Engineer, Willard Storage Battery Company, Cleveland 1, Ohio

RADIO MANUFACTURING: Mr. Fred R. Lack, V. Pres., Radio Division, Western Electric Company, New York City

TELEGRAPH EQPT. MFG.: Colonel Julian Z. Millar, The Western Union Telegraph Company, New York City

TELEPHONE EQPT. MFG.: Mr. C. D. Manning, V. Pres., Kellogg Switchboard & Supply Company, Chicago, Illinois

COMPONENTS MFG.: Mrs. R. C. Ellis, V. Pres., Raytheon Manufacturing Company, Waltham, Masachusetts

PHOTOGRAPHIC EQPT. MFG.: Mr. H. A. Schumacher, V. Pres., Graflex, Inc., Rochester, N. Y.

RADAR: Mr. George F. Metcalf, Manager, Electronics Laboratory, General Electric Company, Syracuse, N. Y.

WIRE MANUFACTURING: Mr. H. Donn Keresey, Pres., Anaconda Wire & Cable Co., New York City

PUBLICITY: Mr. Roland C. Davies, Telecommunications Reports, Washington, D. C.

MILITARY TRAINING: Major Gen. G. L. Van Deusen, Pres., R.C.A. Institutes, Inc., 75 Varicle Street, New York 13, N. Y.

G. Berry, commercial photographer at the E. I. Dupont de Nemours plant.

Sacramento

A dinner meeting was held on February 18th in the Sacramento Signal Depot's Post restaurant. The program included an inspection of the installation and a showing of the film "Plan for Peace." The guest speaker was Mr. M. J. Brickley, Vice President and Registrar at the Sacramento College. His subject was "Hot Spots in the World Today," with special emphasis on Palestine and the Near East.

St. Louis

The St. Louis Chapter at its regular monthly meeting at the Mark Twain Hotel on February 23rd, set the pace by having a Naval officer as the principal speaker. Other chapters probably will follow suit now that the Association has members from all three of the Armed Forces. Capt. Robert J. Foley, Assistant to Admiral Earl E. Stone, Chief of Naval Communications, came on from Washington to deliver a stirring address in which he described his experiences in command of the submarine Gato during operations in the Pacific.

San Francisco

A petition to form a chapter in San Francisco has just been approved by National Headquarters. Details about this latest chapter and names of its officers will be published later.

Washington

The Washington Chapter met at a special Signal Corps luncheon meeting at the War College on March 11th in commemoration of the 85th anniversary of the founding of the Signal Corps. Secretary Royall was the guest of honor and delivered the principal address. Others seated at the speakers' table were Representative Auchincloss of New Jersey; the Chief Signal Officer, Major General Spencer B. Akin; Chief of Ordnance, Major General Everett S. Hughes; the Chief of Naval Communications, Rear Admiral Earl E. Stone; Air Communications Officer, Major General F. L. Ankenbrandt; the Deputy Surgeon General, Brig. General Armstrong; Signal Officer of the Army Ground Forces, Col. Reichelderfer; Signal Officer of the Second Army, Col. Arthur Pulsifer (Secretary of the Baltimore Chapter); and Mr. E. T. Maben, Vice President of the Richmond Chapter.

Secretary Royall emphasized, in his address, the importance of communications in modern warfare. He reviewed the assistance given to military communications by the operating and manufacturing communications industry in World War II and pointed out the vital need for such assistance and cooperation if war should come again.

General Akin, in a brief address, spoke of some of the accomplishments of the Signal Corps and also placed emphasis on the importance for continuing close relations between the communications industry and the Armed Forces. He indicated that the Association can play a most important part in maintaining the cooperation that was so outstanding during World War II.

Vice President and General Manager J. B. Morrison of the Chesapeake & Potomac Telephone Co. presided as head of the Washington Chapter and introduced the speakers and the association guests of honor. Mr. Morrison also commented on the highly successful staging of the luncheon, giving credit in large part to Col. E. C. Cover of the C & P who headed the luncheon arrangements committee.

Mr. A. K. Mitchell, Western Union Washington Superintendent, who heads the Washington Chapter's committee on organization and membership, announced the plan of his group to stimulate participation and growth of the Washington Chapter. The membership drive, Mr. Mitchell said, will be launched with committees in all branches of the communications industry, the armed services, and other government agencies.

New York University

A Student Chapter has just been organized at New York University, and plans are already under way to provide stimulating programs at their meetings. Officers were elected as follows: Nicholas K. Romanofsky, president; Donald E. Protzmann, vice-president; and Robert D. Hawkins, secretary.

Texas Tech

Some fifty members and their guests attended the first meeting of the year on January 19th. Dr. C. D. Eaves, Professor of History at Texas Tech, was the guest speaker.

The chapter won first place with its float in the homecoming parade held at Tech in November, and chapter officials report that the interesting programs presented at their meetings has resulted in a 70% increase in membership since its organization in March 1947.

The current officers are: J. P. Lilly, president; J. W. Stewart, first vice-president; J. L. Southern, second vice-president; T. L. Timmons, secretary; L. R. Goodwin, treasurer; and I. C. Enochs, assistant treasurer.

Signal Corps News

Reeder to General Staff

The importance of military communications and its personnel in current preparedness planning was emphasized by the Army when Major General W. O. Reeder was chosen recently to be Deputy Service, Supply, and Procurement Director on the Army General Staff.

The division General Reeder was chosen to head directs most of the activities of all the technical services, of which the Signal Corps is one, and is the successor to the wartime Army Service Forces.

Until his selection for this higher level assignment General Reeder was Deputy Chief Signal Officer. He will now be in a position to ensure that communications and photography will receive proper attention in all Department of the Army planning during the critical days ahead. He is especially well suited for the assignment because of his knowledge of communications training and supply problems, and because of his experience with communications and the General Staff in the World War II theaters in China, Burma, and India.

Signal Corps Anniversary

The Signal Corps celebrated its 85th Anniversary on March 3rd. The Corps grew out of the work of an obscure Army surgeon, Albert J. Myer, whose systems of signals for communication was developed not for military communication, but in an effort to perfect a sign language for the deaf. Myer, who later became a brigadier general and the first Chief Signal Officer, gave military leaders new means of control over troops under their command with his system of waving signal flags by day and torches by night.

Myer's system was first employed during the Navajo campaign several years before the Civil War, when he and a handful of enlisted men introduced the signals—then called "wig-wag"—by spelling out messages with flags and torches from tree tops and hills.

From this beginning the Signal Corps has developed over the years to become the nerves of the Army. From the signal center in the Pentagon Building, radio, wire, and other channels of communication reach out all over the world to wherever American soldiers are on duty.

Always seeking a more efficient means of achieving its expressed objective, "Get The Mesage Through," the Signal Corps has made many important contributions to the civilian economy. Through the years it has fostered a close kinship with the communications industry and the policy of mutual exchange of ideas has been beneficial both to the military service and private industry.

In looking to the future development of the Signal Corps, Major General Spencer B. Akin, Chief Signal Officer, says the needs of national defense will govern the general course.

"The future program," he said, "actually is being forged day by day, in the laboratories where new weapons and equipment are being perfected and in the evolution of the national defense organization where the inter-relationships of the armed forces and details of the military command structures are being determined.

"The defense problem will be one involving rockets and guided missiles perhaps traveling thousands of miles at terrific speeds far beyond anything we have ever known before. We know that whatever the future defense entails, we must not merely keep abreast of these developments but ahead of them. What we had yesterday is not good enough for today and what we have now probably will not be enough for tomorrow. These factors all aid in shaping future policy and it is Signal Corps tradition to be ready for these emergencies, to overcome the so-called insurmountable barriers and to be ready to accomplish the impossible without delay."

General Akin Receives French Award

Maj. General Spencer B. Akin, Army Chief Signal Officer, has been awarded the Cross of Officer of the Legion of Honor by the French government for his services during and immediately following World War II as Chief Signal Officer of the Far East Command and Chief of the Civil Communications Section of the Allied Powers of Supreme Command in Japan.

Gerald Egan Honored at National Press Club

Gerald Egan, chief editor of the Signal Corps' public information section, and associate editor of SIGNALS, was one of 38 newsmen honored in ceremonies at the National Press Club in Washington, D. C., March 29th. President Truman presented the newsmen, founders of the club 40 years ago, with gold charter membership cards which carry life privileges in the club.

The exercises were attended by 800 newsmen and former press correspondents which included, besides President Truman, Speaker of the House Joseph W. Martin, Jr., and House Minority Leader Sam Rayburn.

An Infantryman in World War I, Mr. Egan is holder of the Silver Star and the Purple Heart.

His father was the noted American diplomat, Maurice Francis Egan, who was U. S. Minister to Denmark under four U. S. Presidents.

Signal Corps to Study Eclipse

The Signal Corps will cooperate, toegether with other Army branches, Air Force, Navy, Bureau of Standards and Coast and Geodetic Survey, with the National Geographic Society expedition which will leave the United States in March to set up seven observation posts for the eclipse next May 8–9. The Signal Corps will establish Shoran radar navigational stations and other electronics devices for the projected measurements of the earth's size and shape during the partial eclipse.

Greek Army Signal Training

Over eight-hundred students from Greek armed forces were trained during January in the use, maintenance, and repair of American signal equipment in courses set up under the supervision of the AMAGS, U.S. Army group. The students completing American signal training in January far exceeded the number for any previous month.

The training courses were set up last August as part of a general training program for Greek armed forces. The importance of American training, is emphasized by the fact that to date more than $850,000 worth of U.S. Army Signal equipment has been allocated for additional signal supplies. Use of this equipment will require considerable numbers of trained personnel and will provide the Greek army with more modern

and efficient signal communications system.

Major Charles P. Reeves of Mount Olivet, Ky., USAG Signal Training officer, said that American supervised courses are given Greek trainees after they finish the British phases of signal training.

While the bulk of the trainees come from the Greek National Army, Major Reeves said, the courses are conducted also for gendarmerie, commandos, and national defense corps battalions.

The training program was accelerated by establishment of signal schools in some divisions as well as in three corps; at the commando training center Vouliagmeni; the gendarmerie training center, Daphne; the technical services training center, Athens; and the signal training center, Haidari. Division schools were temporary and their work has been taken over by corps schools.

How instruction began is an interesting story of improvisation to achieve quick results despite the language barrier. It began several months ago with initial training of four Greek instructors by USAG's three civilian Signal Corps technicians—Carl J. Shaw and Lionel Hirschhorn of Sacramento, California, and Harry E. Pattee of Hammond, Indiana.

The first four Greek instructors in turn trained twenty-five additional Greek instructors who then began instruction courses for trainees sent from various units.

Haidari is the Greek's army's main signal training center located about four miles from Athens. During the occupation the Germans used it as a concentration camp. In a grim stone cell where condemned internees once awaited execution, Mr. Pattee now teaches American switchboard operation.

The courses are from one to three weeks long and include radio operation, switchboard operation, maintenance, and major and minor repairs on all types of American Signal equipment used by Greek military forces.

(The above was cabled to SIGNALS as a press release by Capt. Harry E. Fisher of the Washington Chapter of the AFCA. Capt Fisher is a member of the American military mission in Greece.)

General Akin Makes Address by Radiotelephone

Using Signal Corps communications facilities, General Akin recently spoke from his office in the Pentagon by radiotelephone to a gathering of communications officers in the European Theater and members of the AFCA.

General Akin spoke directly into the telephone instrument in the Pentagon office to his audience in Frankfurt. The circuits to Germany are part of the global Army Administrative and Command network operated by the Signal Corps under the direction of Col. Wesley T. Guest, Chief of Army Communications. While the number of circuits and points of communications overseas have been necessarily diminished considerably since the war, the reliability, efficiency and speed of Army communications are felt by the Signal Corps to have been stepped up substantially.

Armed Forces Institute

Over one thousand Signal Corps servicemen enrolled in the United States Armed Forces Institute (USAFI) courses during the past year and at present there are 194 Signal Corps personnel enrolled in the institute's correspondence courses.

Statistics show that the Signal Corps serviceman is emphasizing education. Never in the history of the Army has there been anything to compare with the present enrollments. The young soldier who expects to stay in the Army a short time is enrolling in courses to learn a trade, obtain a high school diploma or to study college subjects. The career soldier who expects to spend 25 or 30 years in the service is enrolling in courses that will give him a background for promotion or in those courses that will bring him up-to-date on the latest developments in the technical communication fields such as radio, wire, and radar.

One of the means by which a serviceman may obtain his education is through the USAFI program. This is a permanent educational service established as a joint educational service for Army, Navy, Marine Corps, Coast Guard, and Air Force. It provides courses that range from fourth grade English to college mathematics and includes such subjects as agriculture, foreign language, literature, and music; and is available to the serviceman anywhere whether in the United States or thousands of miles away. No matter whether he is stationed in Germany, Tokyo, or the Caribbean he is entitled to use USAFI self-study and correspondence courses.

Mobile Radio Range Extended

Extension of the usable range of mobile radiotelephone equipment from around 100 miles to a distance of 1000 miles was announced by the Signal Corps following experiments with equipment mounted on trucks. A truck equipped with mobile equipment capable of the longer range is now being tested through the South and Mid-West and the equipment soon will be installed aboard a C-82, Air Force transport plane, for tests in flight.

Tax Refund Amendment

Captain Bruce Quisenberry, Chief of the Signal Corps Information Section, has sent to SIGNALS the following, "for any use the Armed Forces Communications Association may make in its publication, in the belief that such information may not generally be known among former, as well as present, members of the Signal Corps."

Section 421 of the Internal Revenue Code was amended by Public Law 367, approved 5 August 1947, to provide, in the case of a member of the armed forces who died while in active service on or after 7 December 1941 and prior to 1 January 1948, for the abatement of all income taxes with respect to the taxable year in which death occurred and all prior taxable years ending on and after 7 December 1941, during any part of which he was a member of the armed services, whether or not the taxes for any such years were paid. If the tax for any such year was paid, it may be refunded if a claim therefor is filed before 1 January 1949. Section 421, prior to the recent amendment, provided for abatement of income taxes only for the year in which death occurred or any prior year for which taxes had *not* been paid prior to death.

The claim for refund of taxes paid in the lifetime of any individual to whom Public Law 367 applies may be filed with the Collector of Internal Revenue to whom the taxes were paid and should be accompanied, as to each year concerned, with a formal Claim for Refund, an amended return for the year showing no tax due and a Treasury Form 1310.

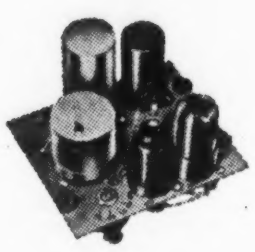
In connection with the foregoing it should be remembered that 18 U.S.C. 198 (Criminal Code, Section 109) makes it unlawful for a Government official to act as an agent or attorney for prosecuting any claim against the United States, or in any manner, or by any means, otherwise than in discharge of his proper official duties, —/to/ aid or assist in the prosecution or support of any such claim, or receive any gratuity or any share of or interest in any claim from any claimant against the United States, with intent to aid or assist, or in consideration of having aided or assisted in the prosecution of such claim.

From these STANDARD components

MICROPHONES

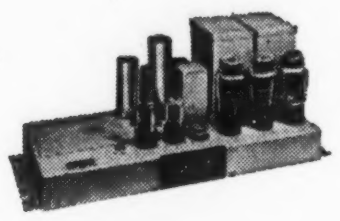
Cardioid types—639A with three different pick-up patterns, and 639B with six.

"Salt Shaker" 633 type — high quality at low cost. (Shown with its directional baffle.)

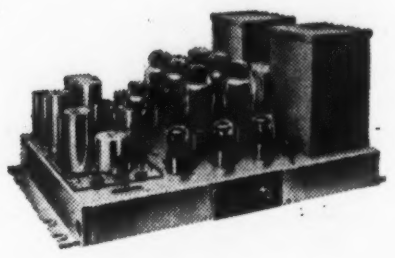


AMPLIFIERS

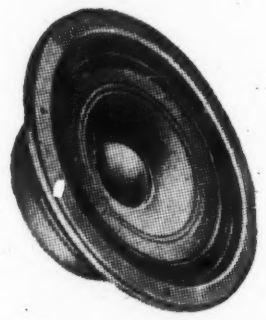
141 — three-stage amplifier (in two envelopes) for operation from microphone and other low-level sources.



142 — power amplifier with 25-watt audio power output. Provision made for mounting a 141 on chassis.



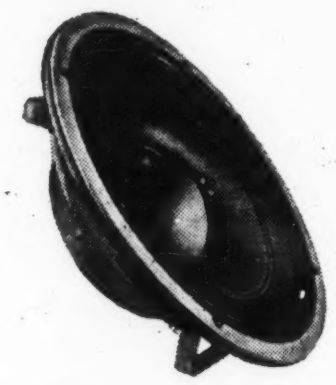
143 — power amplifier with 75-watt audio power output. Shown with a 141 mounted on chassis.



LOUDSPEAKERS

755A — 8″ direct radiator, 8 watts. Frequency range of 70–13,000 cycles.

756A — 10″ direct radiator, 20 watts. Frequency range of 65–10,000 cycles.



728B — 12″ direct radiator, 30 watts. Frequency range of 60–10,000 cycles.

...sound systems can be designed for ANY NEED

Custom-tailor a sound system to meet any requirement—simply by selecting its parts from this line of *standard* Western Electric components. These quality microphones, amplifiers and loudspeakers can be combined like building blocks to form any system from a single-channel set-up to the most complex multiple-channel arrangement. Here's the *simplest* way to the *finest* in sound.

—QUALITY COUNTS—

Western Electric

NAVY NEWS

Stone states need for High Standard of Communications

Despite the problems of demobilization of personnel and reduction in message load, the basic requirements of dependability, speed and security of military communications still must be maintained at the highest standard, Rear Admiral Earl E. Stone, Chief of Naval Communications, emphasized in an address before the Electronics Warfare Division meeting at the Brooklyn Navy Yard.

Admiral Stone discussed some of the recent agreements of the three military services, Army, Navy and Air Force, through the Joint Communication Board, having to do with the common use of facilities, and with communications planning. He described the spirit of cooperation in the approach of all three services to the problem of integrated communication systems as most gratifying.

The Chief of Naval Communications discussed at length the continuing need for integration of military communication systems and facilities, adding that the future planning of the military services includes consideration of the use of commercial companies' facilities to augment existing military links.

Stressing the contributions to victory in World War II of the Naval Reserve, experienced personnel of commercial communications companies, and radio amateurs, Admiral Stone declared that without the efforts of persons from outside the regular Navy "there could not have been victory." He emphasized the continuing need for an adequate Reserve program.

Research and Development Board

Secretary of Defense Forrestal has announced the appointment of Vice Admiral Earl W. Mills and Vice Admiral John D. Price as the new Navy members of the Research and Development Board. Admiral Mills is currently assigned as Chief of the Bureau of Ships. Admiral Price is Deputy of Naval Operations (Air). They succeed Admiral De Witt C. Ramsey and Rear Admiral Paul F. Lee respectively.

Admiral Ramsey has recently been assigned to Hawaii as Commander in Chief, Pacific, and of the Pacific Fleet. Rear Admiral Jerauld Wright, Director of Operational Readiness, is assigned as deputy member of Admiral Price. Rear Admiral Paul F. Lee, Chief of Naval Research, is to serve as deputy member of Admiral Mills.

The Research and Development Board, under the direction of its chairman, Dr. Vannevar Bush, completed its membership and received its formal directive from Secretary Forrestal on December 19, 1947. It succeeds the agency known as the Joint Research and Development Board, which was also headed by Dr. Bush.

Navy GCA Saves Civilian Planes

G. C. A. radar (ground controlled approach) was credited recently by the Navy Department for the safe landings of two civilian commercial planes which otherwise might have crashed in bad weather. Both planes, inbound from Alaska on Jan. 15, found that they were unable to land at the Boeing and Bow Lake Airports at Seattle, the regular commercial terminals and were "talked down" by GCA operators at the Naval Air Station at Seattle.

Subs Being Streamlined

Alterations to a number of fleet submarines are being made under a program designed to increase their submerged speed and to incorporate the results of recent Navy research and German submarine development during World War II.

An improved version of the "schnorkel," breathing apparatus developed by the Germans, is being installed on the undersea fighters during the alteration program.

Labelled the "Guppy" program, the alterations are based upon research conducted in both Atlantic and Pacific waters. Those altered include the *USS Odax* (SS-484), *USS Pomodon* (SS-486), *USS Amberjack* (SS-522), and the *USS Corporal* (SS-346).

The "Guppy" program is the first of a series of basic steps in the Navy's long-range effort to design and construct the true submarine. Operation of the altered submarines will provide information useful in perfecting plans for the new submarines recently authorized by Congress, and will aid in the training of Navy antisubmarine forces against high-speed submerged undersea fighters.

Helicopters for Fleet Units

The Navy has ordered 20 additional HO3's, observation helicopters, from the Sikorsky Division, United Aircraft Corp., in line with plans to equip Navy fleet units with helicopters for rescue, transport, and observation missions.

A total of 46 observation helicopters (HO3S's) are now on order. When delivered, they will bring to 88 the total number of helicopters of all types available for use by Navy fleet and shore-based units, and will give the Navy a fleet of rotary-winged aircraft second to none.

"The helicopter has already proven itself to be of distinct and unique value in carrying out certain phases of fleet operations," Rear Admiral A. M. Pride, U.S.N., Chief of the Bureau of Aeronautics, pointed out.

"Plans are now under way to equip fleet units with these craft for rescue, transport, and observation missions," he added. "The Navy will continue to develop helicopters of even greater versatility and reliability and to integrate them into its fleet preparedness program."

The HO3S, a modification of the civilian Sikorsky S-51 helicopter that is manufactured to Navy specifications, has a cruising speed of 85 miles an hour and a top speed of 110 miles an hour. It has an overall length of 57 feet, is 13 feet high, and has a main rotor disk diameter of 48 feet. Powered by a Pratt and Whitney 450-horsepower engine, the HO3S has a maximum rate of climb of 1,200 feet a minute at sea level.

The auxiliary equipment of the Sikorsky helicopter includes flotation gear for water landings and takeoffs, rescue hoists for lifesaving missions, and extra fuel tanks.

Navy fleet units have been using helicopters on an experimental basis for more than a year. The Sikorsky HO3S-1 was used in Operation Highjump in the Antarctic last winter, and one HTL Bell helicopter and two HO3S Sikorsky helicopters are being used for reconnaissance and transport work by the Navy task force now in the Antarctic.

In addition, the HO3S-1 was employed on various missions during the 1947 spring cruise of the Atlantic Fleet. During a series of trial it successfully flew plane guard for operating carriers—a duty usually assigned to a destroyer—by rescuing six fighter pilots who crash-landed in the ocean. It also delivered mail, and transported personnel from one ship to another. While delivering

RCA scientists—pioneers in radio-electronics—apply the "radio tube" to communications, science, industry, entertainment, and transportation.

This "magic lamp" makes Aladdin's look lazy

You will remember the fabulous lamp—and how it served its master, Aladdin. Serving you, today, is a real "magic lamp"... the electron tube.

You are familiar with these tubes in your radio, Victrola radio-phonograph or television set... but that is only a small part of the work they do. Using radio tubes, RCA Laboratories have helped to develop many new servants for man.

A partial list includes: all-electronic television, FM radio, portable radios, the electron microscope, radio-heat, radar, Shoran, Teleran, and countless special "tools" for science, communications and commerce.

The electron microscope, helping in the fight against disease, magnifies bacteria more than 100,000 diameters, radar sees through fog and darkness, all-electronic television shows events taking place at a distance, radio-heat "glues" wood or plastics, Shoran locates points on the earth's surface with unbelievable accuracy, Teleran adds to the safety of air travel.

Constant advances in radio-electronics are a major objective at RCA Laboratories. Fully developed, these progressive developments are part of the instruments bearing the name RCA, or RCA Victor.

• • •

When in Radio City, New York, be sure to see the radio, television and electronic wonders on display at RCA Exhibition Hall, 36 West 49th Street. Admission is always free. Radio Corporation of America, RCA Building, Radio City, New York City 20, N. Y.

RADIO CORPORATION of AMERICA

guard mail the same helicopter covered the entire task force in less than an hour, whereas a destroyer usually requires a full day to complete the duty.

New Periscope Camera

A new type of periscope camera for the U. S. Submarine Service was disclosed recently by Eastman Kodak Company. It is stated that the new camera can take close-up beachhead pictures at a speed of more than one per second.

The company also reported that it has supplied the Navy's underseas force with a device by which a sheet of film from the new camera can be processed in daylight in less than 60 seconds.

The first models of the new camera were delivered to the Navy late in World War II and were designed to get detailed views of the Japanese shorelines and possible invasion spots.

The pictures it takes are about four inches square. They can be snapped in quick succession and pieced together to form a mosaic of a shoreline. This method often proves more suitable for beachhead planning than does the use of photos from fast-flying planes.

The rapid, "minute - method" of film development is possible when single-exposure sheets of film are used in the camera. The film is in a special case. When removed from the camera after exposure, the film case is dipped into fast-developing, washing, and fixing solutions. The resulting negative is immediately available for study by the submarine's captain.

Generally the camera uses aerial film in 20-ft. lengths which permit 50 exposures. With this film standard development times are required.

Hull Joints I. T. & T.

Capt. David R. Hull, one of the outstanding younger Naval officers who has headed the Electronics Division of the Bureau of Ships for nearly two years, is leaving the Navy to join the International Telephone and Telegraph Corp. as Assistant Technical Director.

He has been succeeded as Assistant Chief of the Bureau of Ships for Electronics by Capt. Alvin L. Becker, who has held a number of key radio and electronics posts during his 25 years of Naval service.

Captain Hull, a graduate of the U. S. Naval Academy in 1925, headed the Electronics Division during the first stages of the difficult postwar task of taking advantage of the vast wartime developments in communications - electronics equipment with the limited funds and manpower available. He begins his duties with the I. T. & T. Monday, March 1, and was formally succeeded by Captain Becker Tuesday, Feb. 24. Captain H. E. Bernstein remains as Deputy Director under Captain Becker. A dinner and reception was given Feb. 27 by the Electronics Division in honor of both Captain Hull and Captain Becker.

To the highly-important assignment of spreading the Navy's funds over a wide variety of electronics procurement and research requirements, including developmental research in Navy and civilian laboratories, maintenance of existing equipment, and progressive modernization of the facilities in use, Captain Becker brings a broad background. Since the end of the war, he has been Electronics Officer at the Mare Island, Calif., Naval Shipyard. During most of the World War II, he was Radio Materiel Officer at Pearl Harbor, and later officer in charge of the Communications Engineering Planning Board at Guam.

At the outset of the war, he served as Executive Officer of the USS Augusta. For three years prior to that, he was officer in charge of the Shore Radio Station Section of the Navy Bureau of Engineering. Earlier service included posts as Radio Officer of the USS New York; District Communications Officer of the 9th Naval District; Battle Force Radio Officer on the USS California; and Division Radio Officer of a cruiser division scouting force. He is a 1922 graduate of the Naval Academy, and received an M.S. degree from Yale in 1929.

Captain Hull was Deputy Director of Electronics for a year before taking over the helm of the Division in the fall of 1946, with the retirement of Commodore Jennings B. Dow. From 1943 to 1945, he was head of the Design Branch of the Electronics Division, and from 1940 to 1943 he served as Assistant to the Director of the Naval Research Laboratory, supervising radar development. Commodore Dow is now a Vice President of the Hazeltine Corp., and of the Armed Forces Communications Association.

Captain Hull's duties were primarily concerned with radio from the outset of his Naval career. After postgraduate instruction at Annapolis and Harvard—he holds an M. S. rfom the latter school—Captain Hull was assigned to staff duties with the Pacific Fleet in technical sonar development work. From 1936 to 1939, he was head of the Underwater Sound Section of the Bureau of Engineering, and in 1939-40 he served as commanding officer of the USS Semmes, an electronics experimental ship.

Annapolis Communications Expand

The U. S. Naval Communication Station at Annapolis has announced plans to expand its facilities.

Land is to be cleared, swamp ground filled in and leveled in preparation for the erection of antenna supports. Plans also include installation of a drainage system.

Centrifuge Spins Steel Ball at 1800 MPH to Test Paint

The Navy is utilizing an "ultra-centrifuge," which spins a small steel ball at a speed of approximately 1,800 miles an hour, to test the adhesive qualities of paint for high-speed aircraft.

A dot of paint is placed on the steel ball, which is suspended in a vacuum in the novel centrifuge and then subjected to a rotating magnetic field. The device was developed by the Navy in conjunction with the University of Cincinnati, Cincinnati, Ohio.

The top of the steel ball, which is a quarter inch in diameter, is slightly flattened like the earth to keep it rotating on a constant axis. At its top speed of 2,400,000 revolutions per minute, its surface speed is approximately 1,800 miles an hour, and its spinning is so swift and friction-free that if power is cut off it will spin on for a week before completely coming to rest.

The fundamental idea was originally used to test the strength of steel bearings. Its application in testing paint was devised by Dr. Walter Soller, of the Applied Science Research Laboratory, University of Cincinnati.

Rotation of the tiny ball is produced by electronic forces outside the vacuum. A rotating field similar to that used in an ordinary induction motor is set up by three coils, which are excited in succession. The speed of the ball is measured on an oscilloscope, which records the passage of the paint dot and a second surface past an electronic recorded. The disappearance of the trace of the paint dot from the oscilloscope indicates that force great enough to throw the paint from the surface has been generated, while the other reference point remains to continue reporting the speed of the rotor.

Going places (AGAIN)

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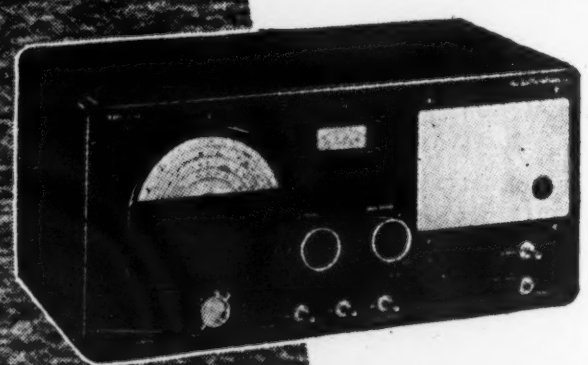
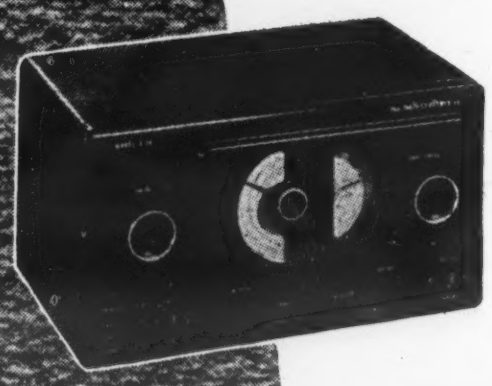
Hallicrafters famous radio equipment, sold and distributed around the world before the war and used with superb effectiveness in every theater during the war is once again on the move. Watch for latest details of the Gatti-Hallicrafters mobile radio equipped expedition to the Mountains of the Moon in deepest Africa—a new and exciting test for the ingenuity of hams and the performance of Hallicrafters equipment.

3 GREAT RECEIVERS FOR HAMS AND AMATEURS

***Model* SX-42** Described by hams who have operated it as "the first real postwar receiver." One of the finest CW receivers yet developed. Greatest continuous frequency coverage of any communications receiver—from 540 kc to 110 Mc, in six bands. FM-AM-CW. 15 tubes. Matching speakers available. **$275.00**

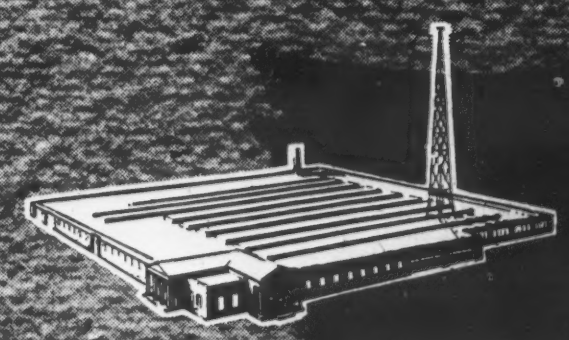


***Model* S-40A** Function, beauty, unusual radio performance and reasonable price are all combined in this fine receiver. Overall frequency range from 540 kc to 43 Mc, in four bands. Nine tubes. Built-in dynamic speaker. Many circuit refinements never before available in medium price class. **$89.50**



***Model* S-38** Overall frequency range from 540 kc to 32 Mc, in four bands. Self contained speaker. Compact and rugged, high performance at a low price. Makes an ideal standby receiver for hams. CW pitch control is adjustable from front panel. Automatic noise limiter..... **$47.50**

Prices slightly higher in zone 2



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AIR FORCE NEWS

Ankenbrandt Promoted

Brigadier General Francis L. Ankenbrandt, Air Force Communications Officer, was nominated for promotion with the temporary rank of Major General in the Air Force by President Truman in the list of Air Force nominations transmitted to the Senate.

At the same time, the President nominated Major General Harold M. McClelland who commands the Airways and Air Communications Service of the Air Force's Air Transport Command, for permanent rank as Brigadier General. Gen. McClelland at present holds the permanent rank of colonel of the U.S. Air Force.

Aircraft and Weapons Board Meets at USAF Headquarters

The Aircraft and Weapons Board of the U. S. Air Force today completed a four-day meeting, the first since organization and initial meeting of the board last August.

The mission of the Board is to determine and chart the aircraft and weapons development and procurement programs of the Air Force, and to consider other related matters referred to it by the Chief of Staff of the U. S. Air Force.

Included in the functions of the Board are the determination of requirements for new aircraft and weapon development projects and the selection of specific aircraft and weapons for procurement. The basic types of aircraft and weapons required to carry out the mission and plans of the USAF were under study at the meeting just ended.

Attending the four-day meeting were General Hoyt S. Vandenberg, Vice Chief of Staff, Chairman; Lieutenant General Edwin W. Rawlings, Air Comptroller; Lieutenant General Lauris Norstad, Deputy Chief of Staff for Operations; Lieutenant General Howard A. Craig, Deputy Chief of Staff for Materiel; and Lieutenant General Idwal H. Edwards, Deputy Chief of Staff for Personnel and Administration, all of USAF headquarters.

Theater and major commanders present were General George C. Kenney, Strategic Air Command; General Joseph T. McNarney, Air Material Command; Lieutenant General Curtis E. LeMay, U. S. Air Forces in Europe; Lieutenant General Nathan F. Twining, Alaskan Air Command; Lieutenant General Elwood R. Quesada, Tactical Air Command; Lieutenant General George E. Stratemeyer, Air Defense Command; Lieutenant General John K. Cannon, Air Training Command; Major General Robert W. Harper, Air Transport Command; Major General David M. Schlatter, deputy commander, Air University; and Brigadier General Carl A. Brandt, Air Materiel Proving Ground.

Brigadier General Frederic H. Smith, Jr., Chief of the Requirements Division in the office of the Deputy Chief of Staff for Operations, served as Secretary of the Board.

New Communications System Aids Air Force Jet Pilots

A new system of radio-telephone communication which permits direct conversation between forecasters and pilots has been inaugurated by Air Weather Service to furnish faster weather advice to high-speed jet aircraft of the U. S. Air Force. The system is being installed to meet problems created by the rapid fuel consumption and high speeds of jet planes.

Properly-timed weather briefing is of critical importance to the jet pilot; in fact, knowledge of the weather situation which will exist at the destination at the exact time of arrival is vital. Due to fuel consumption of such aircraft at low altitudes, often as much as 550 gallons an hour, once a jet pilot has "let-down" to land after a long flight there might be insufficient fuel remaining to proceed to an alternate base some distance away.

Similarly, because of high cruising speeds, a jet pilot might be 100 miles beyond a weather station while waiting a few minutes for briefings to be relayed through the control tower operator. To compensate for this speed and further personalize contact between forecaster and pilot, three USAF bases have installed facilities permitting the forecaster to talk directly with the pilot. Specific information desired by the pilot thus can be obtained immediately while within radio range.

While begun primarily as a necessary aid to jet aircraft, the system will prove advantageous for the future of all air operations, since any type of aircraft may employ this direct communication with Air Weather Service once the remote equipment is installed.

USAF Relieves Flying Congestion in Washington Area

The U.S. Air Force has established an approach control facility at Andrews Air Force Base, Camp Springs, Maryland, to assist in alleviating air traffic congestion in the Washington area under instrument flying conditions.

(The Andrews approach control will use existing GCA (Ground Control Approach) radar equipment at the Maryland base. Previously, this equipment has been used only for local training and for planes going expressly to Andrews.)

Officials of the Air Force and the Civil Aeronautics Administration have agreed that the Andrews approach control unit may offer all Air Force aircraft entering the Washington area in bad weather this additional facility for making instrument letdowns.

This service will also be available to other military aircraft upon request and to civilian aircraft in emergencies. However, the pilot of a USAF aircraft may still elect to use the Washington National Airport radio range in instrument flying weather.

The CAA believes this option of USAF aircraft to utilize Andrews approach control facilities, thereby affording a second bad weather landing facility, will approximately double the capacity of airports in the metropolitan Washington area to handle aircraft under congested instrument traffic conditions.

Until the new facility began operations, aircraft cleared into the Washington area had to utilize the National Airport radio range, which was the sole approach to the airport under instrument conditions available. Under heavy traffic conditions this often resulted in considerable delay between the time of arrival of a plane over Washington and the actual landing. The creation of Andrews approach control will allow USAF aircraft, comprising a substantial portion of Washington's air traffic, to make radar-controlled descents over Andrews Air Force Base, thereby decreasing congestion and delay over other airports in the area.

Ground Control Approach radar is the primary instrument landing aid at Andrews. While in the Andrews approach control area all air traffic will be under observation and control

ground radar operated from the Force Base.

Other aircraft flying at 4,000 feet or below, on an instrument flight plan through the area in which approaching aircraft are being maneuvered by the Andrews radar, will be cleared by CAA's Washington Control after agreement on the clearance is obtained from Andrews approach control. The establishment of this system will greatly multiply the responsibility of Andrews AFB radar installations operated by Airways and Air Communications Service of the USAF.

Under instrument conditions all aircraft desiring to land at Andrews AFB will be transferred from Washington Control to Andrews approach control and assigned an altitude on the south leg of Brandywine Radio Range, located approximately eight miles south of the field. Andrews AFB radar will give instructions to aircraft in turn to follow certain headings from Brandywine range to the final GCA approach controller where they may land under control on Andrews AFB, or proceed visually to other airports in the Washington Area.

The radar used for this traffic control has an effective range of 45 statute miles and is capable of detecting small aircraft moving at high speeds as well as larger, slower aircraft. This type of radar is especially suited to traffic control where jet-propelled aircraft and transport type aircraft are operating in the same area. This radar installation consists of three scopes, one larger "Skiatron" radarscope for air traffic control and two smaller radarscopes, one to identify aircraft and the other to determine directions to bring aircraft within range of the final GCA landing controller.

AF and Sig. Corps Develop Weather Facsimile Network

Development of a weather facsimile service for the transmission of weather maps for the Air Force Air Weather Service was announced jointly by the Air Force and the Army Signal Corps. It is the first such system of its kind and will put at the disposal of Air Force Ground and Flight personnel factual, up-to-the-minute weather data. This material is furnished in the form of a map and requires no further plotting.

Approximately 15,000 miles of circuits are employed in furnishing the facsimile system which comprises four separate networks of telephotography (facsimile) transmission channels. These networks can be interconnected so that one sending station may transmit to all receiving stations.

Hitherto, the transmission of weather information to the forecasters at all domestic Air Force fields has been limited to the use of private line teletypewriter networks of the Air Force and the Department of Commerce.

Now, domestic as well as international weather maps are prepared at the main control point at Arlington, Virginia, and sent from there on an almost half hourly basis to all Air Force bases in the United States. In addition, regional maps are distributed from secondary transmitting points at New York, California, Texas, Oklahoma and Georgia.

Under the new arrangement, once the basic weather information has been plotted and analyzed in chart form, the facsimile method permits the transmission of the completed chart in about 20 minutes. This provides the forecasters at Air Weather Service Stations with comprehensive data from which local and route forecasts can be developed without loss of time and without detailed clerical operations on their part.

Although developed primarily to keep pilots fully informed on weather conditions throughout the country as they are occurring and without the time-consuming process of plotting, the new facsimile service involves important economies as well. It will mean a substantial reduction in personnel engaged in the service of transmitting and receiving weather data over conventional teletype services while eliminating completely, at all but the master and the four regional analysis centers, the exacting task of plotting frequently occurring weather changes.

The service is the result of joint action by the Air Force and the Signal Corps which handled the engineering problems involved through the Long Lines Department of the American Telephone and Telegraph Company in cooperation with the Associated Bell System Companies who provide the communication channels required for this extensive network. The Signal Corps will assume the cost of operation. The machines used to transmit and receive the weather maps are identical with those used in daily newspaper offices for the transmission and receipt of telephotos, and the facsimile newspaper.

Economy of operation and efficiency in the weather reporting service are not the only factors involved, Captain G. D. Furlong of the Signal Corps, pointed out. A more efficient weather reporting service has a very definite bearing on air safety in which the Army and the Air Force have an abiding interest, he said.

Plans are now in the formative stage, he said, for participation in the service by America's commercial airlines.

"The facsimile service such as we are now making available to pilots," Captain Furlong said, "ultimately will make the conventional weather reporting system for the use of pilots obsolete. It eliminates the hazard of surprise changes in the weather which might, if known, alter the flight plan. Thus the ends of safety are served fully as well as the convenience of the pilot.

"The original plan called for a network of 166 stations throughout the country. At the present time, there are 77 stations in operation with 29 currently on order."

Triply-Qualified Aircrews

The U.S. Air Force Bombardment School will enroll 48 students a month, beginning March 1, to bring the school up to operating capacity of 576 graduates a year, all triple-trained navigator-bombardier-radar observers to be assigned to operational units of the USAF.

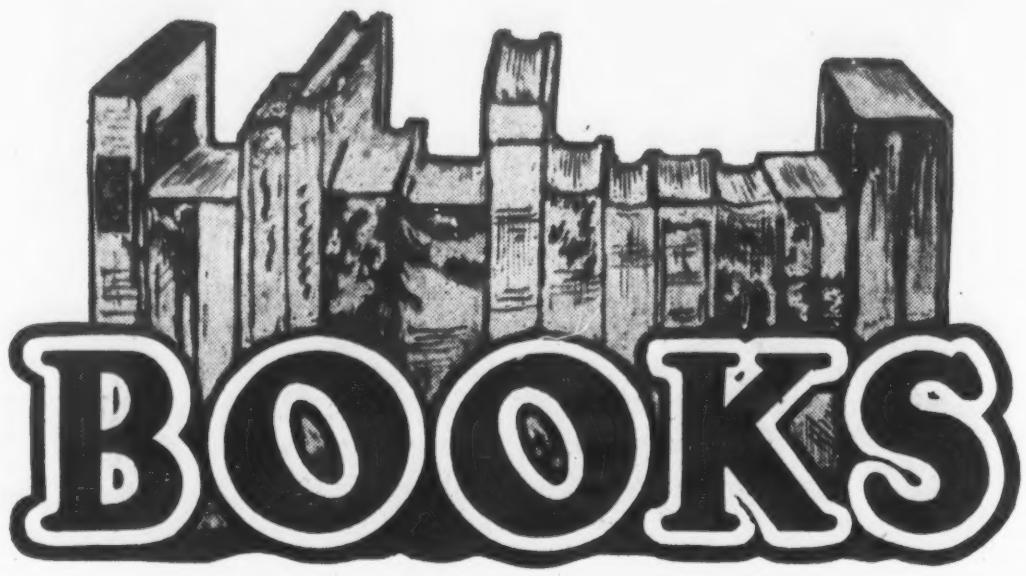
Located at Mather Air Force Base, Sacramento, California, the school now has 126 students who will graduate the newly rated specialists in 1948; thereafter 576 students will be trained each year.

Only bombardiers or bombardier-navigators are being enrolled now, although Air Force navigators and civilian applicants will be accepted after bombing facilities are expanded to permit large-scale bombing training in the course.

The school combines celestial and radar navigation training, radar bombing, Shoran (short-range radio navigation) bombing, and visual bombing. Several of the phases run concurrently, and the entire course requires about 9½ months.

The need for a single crew member trained in all three specialties became apparent in the closing phase of World War II, when a number of flying officers held ratings in two of the three fields.

On light bombardment aircraft, with space for crew members limited, one such officer will perform all navigation and radar bombing functions. On larger, long-range bombers, two or more of the graduates may be assigned to relieve each other on long missions. During combat operations, there would be obvious advantages in having at least two crew members prepared to perform any of the three duties in case of casualties.



AND SERVICES

BOMBER OFFENSIVE, by Sir Arthur Harris, Marshal of the RAF. 280 pages. The MacMillan Co. $2.75.

THE STORY of the British Bomber Command, told by its commander, is a simple, forthright account of tremendous accomplishment despite almost insurmountable obstacles. He says little about the U. S. bomber effort and accomplishment, but emphasizes Britain's concept of night bombing while the U. S. insisted on precision daylight bombing. The book is full of fascinating information on air power. He evaluates his Bomber Command's strategic bombing of German industry and its contribution to the invasion of Europe and its use against the V-weapons.

Sir Arthur relates many interesting personal incidents—from his relationship with Churchill down to everyday happenings with his own staff.

It's an important historical document of World War II and the moving story of a soldier who did a great job.

THE UNQUENCHED CUP, by Lt. Col. W. M. Grimes. Lifetime Editions. $2.50.

FOR THOSE WHO have appreciated the humility, homage and devotion, and thrilled to the glory of the Psalms of David, the very idea of transposing them into modern poetic idiom is startling.

And yet, Willard M. Grimes has achieved that transportation, with warm and human interpretation in his forthcoming book, "The Unquenched Cup."

Mr. Grimes explains that he is not attempting to supersede any of the existing translations, but rather to interest people in the sacred songs, or remind people that they are worth rereading.

It stresses need for proper preparedness to insure peace.

MEN AND VOLTS AT WAR, by John A. Miller. 245 pages. Whittlesey House. $3.75.

THE BOOK deals with research and production contributions made by the General Electric Company and its subsidiaries to practically all arms of the services, and the author has done an excellent job of presenting in clear and readable text the nature of these contributions and their applications in the war theaters. If there are omissions in the text these are exclusive systems and devices produced by other manufacturers. As an authentic record of what was accomplished by industry during the war period, and what could be accomplished again should the need arise, this book should prove of direct interest to engineers, teachers, officers of the armed services and the public in general. In the pages of this comprehensive work the reader may, perhaps for the first time, learn the manufacturing and application facts about instrumentalities which were war secrets.

COMPANY COMMANDER, by Charles B. MacDonald. 277 pages. Infantry Journal Press. $3.00.

COMPANY COMMANDER will grip the heart of every reader with its true characters; the Johnny Doughboys of Companies I and G, 23rd Infantry, 2d Division, who knew what it was to be cold, hungry, afraid, and tired, wondering if it would be better to be killed and perhaps that would be the end of everything; who know the joy of a hot bath and warm food with many days spacing; who shared the thrill of victory with the oppressed people when the glorious day came.

Capt. Charles B. MacDonald, company commander of these Johnny Doughboys, tells what it is like to lead men under fire and to know that lives depend on each decision, each gesture, even each facial expression. His is not simply a story of what the company did, where the men fought but how he himself felt in the long tough months when he led his outfit in combat. If you have ever been a company commander or ever hope to be, you will want to read this true account of how one company comander and his men met the test of war.

THE FIRST CAPTAIN, by Gerald W. Johnson. 312 pages. New York: Coward-McCann. $3.50.

IF AN APOLOGY were needed for another biography of John Paul Jones the fact that 1947 is the bicentennial of his birth might serve. But Mr. Johnson's book would not need an excuse to appear in any year.

It is less of a biography than it is an interpretation of Jones' character and its effect on the subsequent naval establishment. It is Mr. Johnson's well-supported theory that John Paul Jones raised the status of the naval officer to that of a true profession. That a career in the naval service could be an end in itself never seems to have occurred to the ranking members of the European navies where advancement was largely dictated by birth, position, and money, rather than ability.

Newly commissioned officers of our regular services, who in the years to come will be our military leaders and planers in the next war may well ponder these words which the author uses to describe some of the characteristics that should be found in future "first captains":

"In that last sentence suddenly shines out the officer who was an officer indeed. It is a truism that in the armed forces, naval or military, a man's rank is his all. A man who makes the navy his career need not expect success to bring him either wealth or ease; all that he can hope to attain by faithful and able performance of duty is the respect of his country, and rank is the outward, visible symbol of that respect. Thus an officer deprived of his rightful rank is a man hit where it hurts worst. He can stand up better under any other blow.

"In other words, here was a man who acknowledged that nothing, not even insult added to injury, could release him from his obligation to do his full duty. To appreciate the excellence of this attitude, consider what was about to happen to another man who was also considered one of the ablest officers in the American service. Like Paul Jones, Benedict Arnold was kicked around by the politicians, deprived of his rightful rank, blamed for other people's errors, and forced to see the credit for his own good work given to an incompetent fool. But Arnold couldn't take it. For all his brilliance—and he was unquestionably a brilliant soldier—he was never an officer. At best he was a pseudo officer, because the test of personal injury broke him and turned him into a traitor, and true officer has a core of steel, a loyalty that nothing can break."

PREPARING FOR FEDERAL RADIO OPERATOR EXAMINATIONS, by Arnold Shostak. 391 pages. Prentice-Hall. $3.75

WHETHER ON shipboard, in aircraft, or on land, professional or ham, the radio operator must be licensed.

Selections of the questions in this book make up each Federal examination. If the student knows the answers to these questions he can't fail his examination. Following each question is its answer, given in the most direct and simple form. Theory and practice of radio, technical and legal, are covered.

Not a textbook, this is a practical workbook, essential for any candidate for any one of the six classes of radio operator. It also teaches the rudiments of radio practice in such manner as to help licensees in the performance of their duties as radio station operators.

ANOTHER DAY—ANOTHER DOLLAR, by J. T. Winterick—J. P. Lippincott Co., publishers. 204 pages. $2.50.

A HUMOROUS ACCOUNT of the author's boyhood in an eastern city in the first decades of the 20th century. He wrote it soon after he first entered the Army to serve in World War II when he was directed to complete a form showing all of his many civilian positions. That takes him 'way back since he first earned a little money at the age of 8. But there is at least one serious page that will interest the American who is concerned with military matters and the armed forces and their effectiveness. In these days when it often seems that there may be a well organized campaign to ridicule and belittle the military and their works that page should be read even by those who don't read the book. The Infantry Journal thought so well of it that they devoted two whole pages and special featuring to it. Here it is.

"One afternoon (in 1910) I visited West Point, making the journey on a small launch whose owner operated it as a ferry. He who has not seen Retreat at West Point has missed one of the most soul-stirring spectacles that this land has to offer. I saw Retreat, that first time, under particularly favorable circumstances. West Point was comparatively inaccessible in those days. There were no busloads of tourists up from New York, no cars bearing the license tags of the forty-eight states. I am glad that today the citizenry can take in Retreat in such quantities, but I am equally glad that I enjoyed my own initiation to the ceremony in an approximate privacy. Of the handful of spectators who were present I recall only a presumable Civil War veteran who, as the flag slid down the staff, placed his hat at his bosom and gazed unflinchingly into the sunset. A tingle shot up and down by spinal cord and I felt fully three thousand per cent American. God was in His heaven and all was well with the Union, even if the plump and amiable occupant of the White House did happen to be a Republican.

"In the files of gray-white-clad cadets who strode stiffly and splendidly by, there were some whom destiny had marked for her own, (if destiny actually does any marking, and a good many soldiers, particularly those who get to hear guns go off, find some degree of comfort in maintaining that she does). There were certain others present who, for my money (and for yours too, O fellow-taxpayer), would remain little better than public charges for the rest of their military careers. But strike the balance, assess the average, and it is vastly to the good. Let us lift the veil of the future (which is no trouble at all, without benefit of destiny, after this interval) and see who some of these youngsters are and what they are going to do.

"Here is Cadet Bradford G. Chynoweth. Thirty-two years from now, a brigadier general, he will be a prisoner of war of the Japanese, taken in the fall of the Philippines, and he will remain in enemy hands for more than three years.

"Here is Cadet William H. Wilbur who, just before his promotion from colonel to brigadier general thirty-two years later, will receive his country's highest award for valor, the Congressional Medal of Honor, for a series of exploits in the North African landing. Read his citation: 'On November 8, 1942, he landed at Fedala with the leading assault waves where opposition had developed into a firm and continuous defensive line across his route of advance. Commandeering a vehicle, he was driven toward the hostile defenses under incessant fire, finally locating a French officer who accorded him passage through the forward positions. He then proceeded in total darkness through sixteen miles of enemy occupied country intermittently subjected to heavy bursts of fire and accomplished his mission by delivering his letters to appropriate French officials in Casablanca. Returning toward his command, Colonel Wilbur detected a hostile battery firing effectively on our troops. He took charge of a platoon of American tanks and personally led them in an attack and capture of the battery.'

"Here is Cadet Millard F. Harmon, who in 1917 will become one of America's first combat pilots. Twenty-five years later, after commanding Army Air and Ground Forces in the campaign for the Solomons, he will be named Commanding General of United States Army Forces in the South Pacific Area. In March, 1945, he will make his final flight into the unknown, and a year later will be officially declared dead.

"Here is Cadet Brehon Burke Somervell, whom in 1918 will win the Distinguished Service Cross for an exploit during the Meuse-Argonne campaign, the greatest battle ever fought up to that time by American troops: 'Voluntarily serving on the staff of the 89th Division, he conducted the first engineering reconnaissance of the damaged bridges at Pouilly, where with two scouts he advanced more than two hundred meters beyond the American outposts, crossing three branches of the Meuse River and successfully encountering the enemy.' In the Second World War, with the rank of general, he will command the world-wide operations of the Army Service Forces.

"Here is Cadet Carl Spatz. He too, will become one of his country's first military pilots, and will receive the Distinguished Service Cross for bravery in France in 1918: 'Although he had received orders to go to the United States, he begged for and received permission to serve with a pursuit squadron at the front. Knowing that another attack was to take place in the vicinity of Verdun, he remained on duty in order to take part. On the day of the attack west of the Meuse, while with his patrol over enemy lines, a number of enemy aircraft were encountered. In the combat that followed he succeeded in bringing down two enemy planes. In his ardor and enthusiasm he became separated from his patrol while following another enemy far beyond the lines. His gasoline giving out, he was forced to land, and managed to land within friendly territory.' Nine years later, in the era of boom and bust, he will be awarded the Distinguished Flying Cross for keeping the airplane "Question Mark" in the air over southern California for one hundred and fifty hours, fifty minutes, and fifteen seconds—seventeen hours, nine minutes and forty-five seconds short of a full week. In 1937, weary of hearing himself called "Spats," he will add a second a to his name and be called "Spots." In 1943 he will assume comand of United States Army Air Forces in the North African Theater, and, in 1944, of the United States Strategic Air Forces in the European Theater. Two years later he will be appointed Commanding General, Army Air Forces.

"Here is Cadet Alexander McCarrel Patch, who as an infantry officer will participate in three major operations in France in 1918. In 1942 he will command Army, Navy and Marine units on Guadalcanal in the Solomons. In 1944 he will assume command of the Seventh American Army in Sicily, and will remain with it throughout the operations in France and Germany that are to follow. He will return to the United States to die of pneumonia at Fort Sam Houston in March, 1945. Thirty-two years after this Retreat ceremony of 1910 another Alexander McCarrell Patch will receive his commission as second lieutenant under the Victory Monument at the northern end of the parade ground and will move at once into the final testing school of battle. On October 20, 1944, he will be killed in action in Alsace while serving as an infantry captain with his father's Seventh Army.

"That first visit to West Point was made, as I say, in 1910. I should have gone back the following year and watched the workout of a couple of plebes named Omar N. Bradley and Dwight D. Eisenhower."

Our Book Department can furnish, in limited quantity, any book currently in print. We will also help you to secure older titles that you may need to complete your library. A 10% discount is allowed all Association members on orders of $2.50 or more except for technical books. Please indicate author and publisher where known, and allow at least three weeks for procurement and delivery.

CIVILIAN COMPONENTS

Retirement Legislation

New retirement legislation is on the Congressional docket. The subcommittee on retirements of the House Armed Services Committee is planning to push to a vote the bill giving the Army and Air Force the same privileges of retiring in temporary wartime grade that the Navy, Marines and Coast Guard have had for more than two years. This is in spite of Bureau of the Budget opposition to a provision of the bill setting up a non-disability retirement system for the National Guard and Reserve components of all services. This provision would allow non-Regulars retirement pay at the age of 60 after 20 years' service, up to four of which must be be Federal. Grade in which retired would be the highest held, permanent or temporary. Pay formula: two and one-half per cent x years of active Federal service at time of retirement x active duty base and longevity pay of grade or rank in which retired, plus one-half of one per cent x years of inactive service at time of retirement x active duty base and longevity pay of grade or rank in which retired; maximum, 75 per cent of active duty pay.

Consolidation Opposed

Major General E. A. Walsh and Major General Milton A. Reckord, representing the National Guard Association of the United States and the Adjutants General Association, told the Committee on Civilian Components (Gray Board) recently, that these groups opposed any consolidation of the National Guard and the Organized Reserves which would destroy the traditional local community basis of the National Guard.

If a consolidation were found to be necessary, they said, it would be accomplished by integrating Organized units of the Reserves into the existing pattern of the National Guard, preserving the identity of the latter.

General Reckord and General Walsh, appeared at an open hearing of the Committee on Civilian Components, of which Mr. Gordon Gray, the Assistant Secretary of the Army is Chairman. This was the last of five open hearings held by the Committee, which was appointed by Secretary of Defense Forrestal to study the problems of the reserve components of the armed forces.

General Walsh joined with General Reckord in opposing any change in the status of the National Guard, which they described as a "going concern," and cited statistics to show that it has been recruited from virtually nothing at the close of World War II to approximately 215,000 officers and men today.

Tours of Active Duty

In general, the duration of active duty training tours for members of the Organized Reserve Corps will be limited to ninety days. It is intended that the individual Reservist be limited to one active duty training tour of from sixty to ninety days, or to an accumulation of shorter tours not to exceed ninety days, per calendar year.

It is realized that a too rigid application of the foregoing may operate to the detriment of the service in certain cases. Accordingly, Army Commanders are authorized to approve reasonable additional periods of active duty training in exceptional cases wherein the duty involved is important and requires the further services of the individual.

All Non-Regular Officers in AF Must Join Reserve or NG

More than 10,000 non-regular officers in the United States Air Force must apply for appointment to the Officer's Reserve Corps by March 1 or be relieved from active duty by April 30 to comply with a recently-issued directive aimed at stabilizing the officer strength of the USAF.

The directive is based on Public Law 239, 80th Congress, which terminates, as of July 1, 1948, the appointment of Army of the United States officers in certain categories, and makes it necessary for all non-regular officers to be members of either the Reserve Corps or the National Guard to remain on active duty.

Separation proceedings will begin immediately for non-regular officers who do not apply for Reserve commissions.

Also affected are officers holding Reserve appointments dated prior to June 28, 1945, since commissions in the Reserve Corps are made for five-year periods and must be renewed to remain in effect.

The USAF said the acceptance of an Officers' Reserve Corps commission would not affect an officer's temporary grade.

Non-Regular Army Officers

Changes affecting extended active duty tours for civilian component officers now on duty with the Army and those to be called to extended active duty in the future were announced by the Department of the Army.

The changes, which became effective on March 1, modify the present category system for retention of non-regular officers on active duty formulated shortly after the end of the war. They introduce maximum age limits for those now on active duty as well as for calls to extended active duty for Reserve and National Guard officers. They also establish fixed time periods for length of tours.

Three new categories have been established. Only the present Category V, which includes officers now on active duty who desire to return to civil life at the earliest opportunity, remains unchanged. All qualified officers now on duty who wish to sign new category statements must submit their applications on or before April 30. The category selected, however, must be for a period that will expire prior to the time the applicant will reach his maximum age in grade.

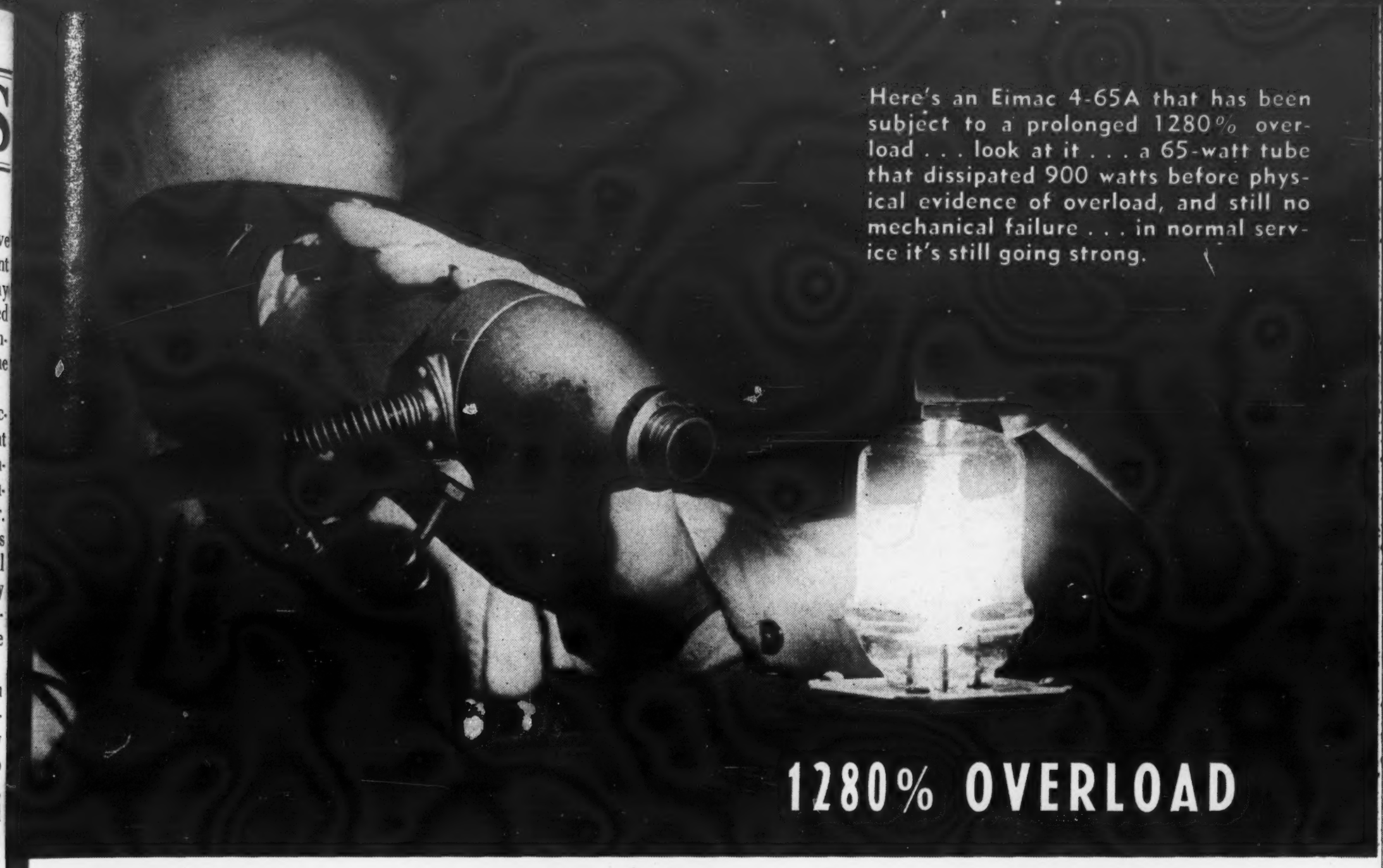
Category I provides for a one year period of active duty and is open to Medical Department officers, other than those of the Medical Service Corps, and to officers now on active duty who are able to complete one year's service, but not a two or three year category by virtue of age.

Category II calls for a two year period of duty and eligible applicants include Officer Candidate School graduates commissioned subsequent to March 1, 1948; officers on competitive tours for appointment in the Regular Army; Medical officers other than those of the Medical Service Corps; and officers now on active duty who cannot apply for a three year category because of age limitations.

Category III, comprising a three year tour, may be elected by qualified civilian component officers now on active duty and who will not reach the maximum age in grade prior to the termination of the category commitment.

To be eligible for active duty in any of the new categories, applicants must hold a Reserve commission dated subsequent to June 28, 1945, or a National Guard of the United States commission.

The new maximum ages in grade



Here's an Eimac 4-65A that has been subject to a prolonged 1280% overload . . . look at it . . . a 65-watt tube that dissipated 900 watts before physical evidence of overload, and still no mechanical failure . . . in normal service it's still going strong.

PYROVAC . . . A NEW EIMAC PLATE MATERIAL

The story's out . . . Pyrovac, a new Eimac plate material, the culmination of ten years research and millions of hours of life test data, is now in standard production—at no extra cost.

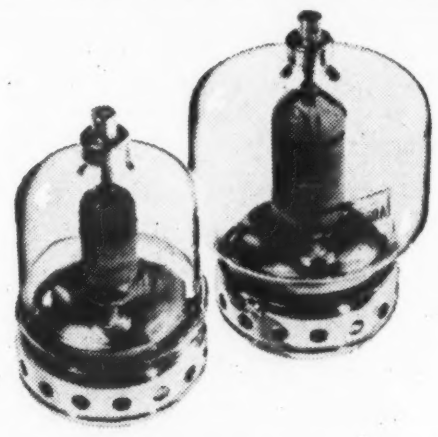
Pyrovac is truly as important a milestone of vacuum tube development as the thoriated tungsten filament. Pyrovac plates, like the thoriated tungsten filament, open a new vista for vacuum tube life performance.

This new material combines the advantages of tantalum to overloads, molybdenum's strength, weight and conductivity, and carbon's ability to dissipate heat . . . with none of the disadvantages of these materials. Tubes with Pyrovac plates are mechanically rugged, require no additional getters and they do not gas even under extreme overloads.

The life span of tubes with Pyrovac plates far exceeds that of tubes incorporating plates of conventional materials. For example, under conditions where a tube gave 3000 hours of service the same tube type with a Pyrovac plate gave 15,000 hours of life, a 400 percent increase!

Pyrovac plates are capable of handling overloads in excess of 1000%. For instance, the 4-65A plate pictured above was radiating 900 watts of heat, a 1280% overload . . . without indication that the eventual life of the tube or its characteristics were affected. We don't suggest you dissipate 900 watts of heat in your Eimac 4-65A's (you could probably do it), but this example establishes proof that Pyrovac is a superior plate material destined to become the anode standard of the vacuum tube industry.

Pyrovac plates were first incorporated in the Eimac 4-250A in the early part of 1946 and followed in the 4-125A As a result there has been universal acceptance of these tubes in all fields of electronic endeavor. . . . Further proof of the superiority of this new plate material. In the ensuing period of



Type 4-125A

Type 4-250A

time all Eimac internal anode type tubes have been converted to Pyrovac plates as rapidly as production facilities would allow.

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TUBES
The Power for R-F

apply to all non-regular officers except those of the Chaplains Corps and the Medical Department, other than the Medical Service Corps. Top age in grade for warrant officers is 55 years. The maximum ages for officers from second lieutenant to colonel in order to continue on active duty are as follows:

Second Lieutenant ..	35 years
First Lieutenant	40 years
Captain	45 years
Major	50 years
Lieutenant Colonel ..	55 years
Colonel	60 years

Former Enlisted Men Honored

Three more Federally recognized General Officers of the National Guard, now engaged in the reorganization of the Guard in their home States, began their military careers as enlisted men.

They are: Brigadier General Theodore A. Arndt, Camp Rapid, Rapid City, Adjutant General of South Dakota; Brigadier General Guy N. Henninger, 2054 South Street, Lincoln, Adjutant General of Nebraska; and Brigadier General Errol H. Zistel, Carter Hotel, Cleveland, Commanding General of the 55th Fighter Wing of Ohio.

General Arndt enlisted as a private in the South Dakota National Guard in May of 1922. General Henninger has a lifetime record of military and public service in Nebraska. He enlisted in January, 1918 as a Private First Class in the Signal Corps Reserve at Fort Omaha, Nebraska. The commanding general of the 55th Fighter Wing, General Zistel, who is rated as command pilot and aerial observer, began his military career in April, 1917 when he enlisted in the Aviation Branch of the Signal Corps at Fort Monroe, Virginia.

NG Air School

More than 300 National Guard and United States Air Force officers attended the Guard's first post-war air indoctrination school at Brooks Air Force Base, San Antonio, Texas, on February 25–27. All 48 states, Hawaii, Puerto Rico, and the District of Columbia were represented in the group.

The three-day course included discussion of all problems of organization, administration, training and operations of the new Air National Guard. National Guard Bureau sent 19 representatives, while the Department of the Air Force sent 15 officers. The six numbered Air Forces were represented by 43 officers and the headquarters of the Air Defense Command sent 12 representatives. Fifty-two Senior Air Instructors attended the conference.

The agenda for the course was arranged by the National Guard Bureau under the direction of its Chief, Major General Kenneth F. Cramer. Colonel W. A. R. Robertson, chief of the Bureau's Aviation Group presided at the sessions of the three-day course.

Electronics Battalion

A reserve electronic warfare battalion at the New York Naval Shipyard is training qualified personnel in all phases of electronics. Graded courses in electronics theory and practice are conducted, and the men work with the latest types of radar, sonar, loran, and communications equipment.

The battalion, under the direction of T. H. Neely of the Naval Reserve, operates the master control radio station for the Naval Reserves in the Third Naval District. The station also transmits on the amateur radio bands with the call sign K2NR and has made contact with amateur stations all over the world.

More Affiliated Units

The International Telephone and Telegraph Company has agreed to sponsor four Signal Corps affiliated units in the Organized Reserve, including a Headquarters and Headquarters Detachment Signal Service Battalion, a Radio Relay Company, a Signal Radio Maintenance Team and a Multi-Channel Radio Teletype Detachment.

66th SC Battalion

The 66th Signal Operations Battalion, sponsored by the New York Telephone Company under the Signal Corps Affiliated Plan, was formally activated into the Organized Reserve at a recent ceremony in New York. Lieut. Col. John E. Drum, a construction superintendent of the company, assumed command of the unit, which served with distinction during World War II in Europe and the Philippines and later in Japan, where it was deactivated. Among others attending were Carl Whitmore, president of the New York Telephone Company, and Col. Grant A. Williams, Signal Officer, 1st Army.

NG Anti-Aircraft Units

A network of 430 anti-aircraft units with 17,665 officers and men in 25 States, the District of Columbia and Puerto Rico has been Federally recognized. They are part of 870 AAA units in 123 AAA Battalions, including 41 Signal Radar and 21 AAA Ordnance Maintenance units allotted the postwar National Guard.

At full organization, the anti-aircraft artillery section of the National Guard will be manned by approximately 80,000 officers and men.

Organization of the 870th AAA AW Battalion of New York City was completed during the week ending February 29 with the Federal recognition of the unit's Medical Detachment. Five anti-aircraft battalions of the 16 allotted New York now have completed organization. Of the 103 AAA component units allotted New York, 54 have gained Federal recognition.

The AAA battalions Federally recognized to date are the 369th and 773rd Mobile Gun Battalions, the 212th Mobile Automatic Weapons Battalion and the 870th self-propelled Automatic Weapons Battalion, all of New York City; and the 898th self-propelled Automatic Weapons Battalion of Rochester.

Naval Reserve Training

In an address at the National Press Club, Washington, D. C., Admiral Louis E. Denfield stated that more than 300 Naval Reserve training stations are being established in centrally located communities throughout the United States. The Chief of Naval Operations said also that approximately 170 vessels from the Reserve Fleet have been assigned as training ships for Reserve activities and that eighteen subs are participating in the program. Twenty-three Naval Air Reserve training bases, he said, will protect the Navy's wartime investment in training of flight and maintenance crews.

ROTC—Honor Students

The following Air and Signal ROTC units have announced their desire to select an honor student for the annual AFCA award at their college:

Rutgers University
Michigan State College
Kansas State College of Agriculture and Applied Science
Iowa State College
Agricultural and Mechanical College of Texas
Purdue University

Next year it is anticipated that the number will be greatly increased with Naval ROTC units becoming eligible in addition to Army and Air units.

Monmouth Trains Reserves

Three courses in basic Signal Corps subjects will be conducted during 1948-49 at Fort Monmouth, N. J., for officers of the Regular Army, Organized Reserve, and National Guard.

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Letters TO THE EDITOR..

Sir:

"It is noted with great interest that you will hold your second annual convention at Wright Field this year and I am very glad that you have it in mind to extend an invitation to the College to be represented. We will be honored to accept this invitation, if and when you find it possible to extend it."

E. B. McKinley
Brig. Gen., U.S. Army
Commandant
Industrial College of the
Armed Forces

Sir:

"I take great pleasure in enclosing my application for membership and my personal check in the amount of $4.00 for one years national dues in the Armed Forces Communications Association.

"It has long been my belief that such an organization has been sorely needed to represent communications and radar interests in the Armed Forces. New developments in radar and communications fields have been neglected by the various services, apparently unaware that the efficient operation of any military or naval force is completely dependent upon the operation of its communication branches. I will be only too pleased if my membership will enable the Association to protect our country's interests and enable its Armed Forces to outdistance any competition in the fields of communications and radar developments."

W. R. Whittington
California

Sir:

"I am forwarding a letter from Captain Hays, Commanding Officer of the 511th Airborne Signal Company, which I feel sure will make for an interesting spot news item in *Signals*.

"The company served as Division Signal Company of the 11th Airborne Division and fought in the Pacific from New Guinea to the Philippines to Japan. They are now doing occupation duty at Camp Crawford, Sapporo Hokkaido, Japan.

"I am very proud of this company as they always come through in a big way as evidenced by the large contribution to the "March of Dimes." Their donation was half the amount of all Special Troops donations put together.

"This type performance is only natural from a group who have a great espirit de corps. They are all volunteers and rated parachutists in addition to being trained Signal Corps Technicians. A man has to be a real soldier to measure up to their standards."

J. E. Gonseth, Jr.
Lt. Col., Sig. Corps
Division Signal Officer

Encl:

"I wish, at this time, to laud the men of the 511th Airborne Signal Company and also make it known to all, the splendid cooperation shown by these men during the recent "March of Dimes" campaign.

"The men of this unit contributed a total sum of $1045.51 during the drive. At that time the assigned strength showed a total of 242 men but the above sum was donated by the 184 men that were present for duty. The average donation per man is $5.68.

"It is such cooperation that makes for a better and more efficient company and will subsequently be better soldiers."

Fred J. Hays,
Capt., Signal Corps
Commanding

Sir:

"I have read your offer in the February, 1948 QST, and am writing to apply for membership in your association. I have been a radio amateur for 24 years, 15 years as radio and transmission engineer, Signal Officer, and all phases of communications. I have designed and constructed high power radio stations, extensive telephone and telegraph networks, and am a member of the Institute of Radio Engineers, the Institute of Electrical Engineers, and am a graduate of the Army Signal School, Fort Monmouth, N. J. I have operated Amateur Radio Stations in Haiti, Nicaragua, and China. My calls were NY6K, W-3DDA, XU-3UA."

M. H. Mizell
Lt. Col. USMC, (ret)

Sirs:

". . . Indeed your magazine SIGNALS has been great, as evidenced by the number of people who want to borrow my copy of each issue."

B. S. Miller
Neptune, N. J.

Sir:

"I take pleasure in informing you that the Signal Corps ROTC Senior Unit at Rensselaer Polytechnic Institute will submit the name of an honor student for the Army Signal Association Award for next spring. Although we have just launched this unit this semester, and therefore are small in numbers, the impetus and competitive spirit induced by the Army Signal Association Award, will tend toward a finer commissioned personnel and a better leader in the communication field.

"Your undertaking is a notable and spirited one, especially being carried out by a civic organization. May I hope that the other universities will also cooperate with you in your admirable plan."

S. Dondes

Sir:

"In reading your very interesting Spring 1946 Issue I ran across a statement on page 64, "In late 1944 two Field Engineers accompanied the first Radio Link communication equipment to France. This very-high-frequency apparatus . . . was used for communication between the 12th Army Group Headquarters and the 15th Army in Europe.

". . . For the record, I wish to report that in August 1944 Radio Link telephone communication was established between 12th Army Group Headquarters, then near St. Sauveur de Lendelin in Normandy, and 3rd Army Headquarters, then somewhere east of Avranches, under the direction of Major Eugene Halpin. At that time, General Patton's forces were moving so rapidly that it was impossible to maintain wire communication and Radio Link proved invaluable. Soon thereafter, similar communication was also established with the 1st Army and subsequently with the 9th and 15th Armies when they arrived on the Continent. It was continuously employed thereafter as a supplement to and standby in case of failure of wire communications.

"An amusing incident occurred after the WAC operators arrived in Paris in the Fall of 1944. In view of the fact that VHF communication was subject to interception, telephone operators of the 12th Army Group Headquarters always warned the calling party, when establishing connection on such a circuit, 'You are connected on a non-secret Radio Link. The enemy is listening.' One day a call came up from Paris to be switched at the 12th Army Group switchboard to one of the Army Headquarters. Since all the wire lines were busy, the operator connected to a VHF circuit and made the usual announcement. The WAC operator in Paris then spoke up and said, 'Well, never mind. I'll call back later when he isn't listening.'"

Frederick H. Kuese
Brookville, L.I., N.Y.

SCIENTIFIC DEVELOPMENTS

Facsimile and Teletype over a Single Radio Channel

Successful results were recently achieved in an application of old principles to the problem of non-interfering transmission of two separate radio signals over one narrow radio channel without dividing the available power between the signals. The tests were conducted by HQ Airways and Air Communications Service, under the direction of Major General Harold M. McClelland, using AACS receiving facilities at Bolling Field with transmitting facilities generously made available by Mr. A. G. Cooley, of the Times Facsimile Corporation.

Over a single radio channel both teletype and facsimile signals were transmitted from W2XIK to the Airways and Air Communications Service at Bolling Field, Wash. The teletype signals shifted the frequency of the radio carrier in accordance with the FS modulation system. The SCFM facsimile signals amplitude modulated the radio frequency carrier in accordance with standard AM practice.

A O-5/FR exciter unit was connected between the teletype transmitter and a Wilcox 96C radio transmitter. A converter unit CV-2/TX converted the amplitude modulated facsimile signals to sub-carrier frequency modulated (SCFM) signals which were applied directly to the voice channel of the radio transmitter.

A frequency shift of plus or minus 425 cycles represented the teletype signals and a tone swing between 1500 and 2300 cycles represented the facsimile signals. About 40% amplitude modulation was applied to the radio transmitter by the SCFM signals. About 1000 watts of RF power fed a doublet antenna on top of the Times Building in New York.

The radio teletype signals were received by the AACS at Bolling Field on a standard AN/FGC-1 radio teletype terminal installation. The facsimile recording equipment included a conventional radio receiver, a standard CV-2A/TX converter modified for 1500 to 2300 cycle operation and an AN/TXC-1 recorder. Fully satisfactory recording of both teletype and facsimile signals was obtained over several days.

The combination of FS and SCFM applied to the radio channel made two communication channels available without sacrificing power in either channel. The usual method of applying two signals to a single radio channel by separating them into two frequency bands is not as efficient because the power has to be divided between the two channels.

Threat of "Home" Guided Missiles Studied

The proposal from the segment of the broadcasting industry, advocating clear channel standard broadcasting, for twenty 750 kw clear channel stations, is understood to have occasioned concern in the military services, Army, Air Force and Navy, because of the threat of such high-powered broadcasting stations becoming "homing devices" for guided missiles. Undoubtedly, this situation will be considered most seriously by the FCC in its determination of the clear channel broadcasting plans which the Commission had just concluded with oral arguments. Of course, the high powered emissions of such broadcasting stations do have some use in aiding aircraft of the country where they are located in being guided to their destinations, although the aviation services and industry have their own specialized air navigation electronic and radio devices which are much more valuable in guiding airplanes to their airports.

World's Highest "Window"

A new astro-window through which navigators aboard long range stratosphere airliners will "shoot" the stars, even in daytime, has been developed by Bausch & Lomb Optical Company.

Designed for Air Force and commercial ships, the streamlined "window" consists of two plates and is capable of withstanding a total force of three and one-half tons. Its surface projects only two and one-half inches above the ship's skin as compared to six inches in the old-type, speed-retarding astro-domes.

The astro-window's outer plate is a large optical lens that has been ground and polished to reduce refraction errors regardless of the angle of the sighting instrument. The inner plate is plastic and houses a defrosting system that should prove "invaluable to celestial navigators," according to its designer, Edward F. Flint.

While he declined to reveal the pressure capacity per square inch of the new astro-window, he said it "outdoes by far all contemplated requirements."

He reported that on stratosphere flights, the astro-window eliminates much of the difficulty encountered by navigators in shooting the stars, even the dimmer ones, regardless of the weather or the hour of day or night.

"The higher man flies," he said, "the plainer the stars become, allowing for continuous and accurate aircraft fixes anywhere over the earth. Contrary to popular notion, the higher you go, the simpler sextant observations become. In the stratosphere the sky tends to become darker and stars are readily seen in the daytime."

On overseas hops, he said, fixes are taken about every half-hour with modern bubble sextants, two of which are standard equipment on long range aircraft.

Pulse Code Modulation

In a Bell System technical article, H. S. Black and J. O. Judson describe a radically new modulation technique for multichannel telephony which involves the conversion of speech waves into coded pulses. This new technique is called Pulse Code Modulation or simply PCM. An eight-channel system embodying these principles was developed and produced in portable form for field operation. Other work carried on simultaneously by W. M. Goodall (Bell System Technical Journal, July 1947) resulted in the development of an experimental system using a different method of coding.

In carrying out this new type of modulation, the speech wave applied to each channel is, in effect, transmitted sample by sample, and each sample is represented by a multi-unit code employing on-or-off pulses, hence the term PCM.

This method appears to have exceptional possibilities from the standpoint of freedom interference. Its full significance in connection with future radio and wire transmission may take some time to reveal.

CHANGES IN KEY PERSONNEL

Changes as of 29 February 1948

Matejka, Jerry V. Changed from Brig General, AUS to Maj General, AUS. Date of Rank—9 November 1944.

Reeder, William O. Changed from Brig General, AUS to Maj General, AUS. Date of Rank—13 November 1944.

Corput, Rex V. D., Col. Acting Chief, Signal P & O Division eff 5 Feb 48.

Pochyla, Benjamin H., Lt. Col. Assistant Deputy Chief Signal Officer eff 17 Feb 48.

Hildreth, Raymond C., Co. Retiring eff 29 February 48.

Watts, Laurence, Col. Retiring eff 29 Feb 48.

Mack, William, M., Col. Commanding Officer, Lexington Signal Depot eff 1 Mar 48.

Rosengren, Walter J., Col. Actg Commanding Officer, Baltimore Signal Depot eff 1 Mar 48.

Promotions:

General Orders No. 11, 2 February 1948, announced the following list of Signal Corps officers recommended for promotion to the permanent grade of colonel, RA:

Brig. Gen. George I. Back; Brig. Gen. Francis H. Lanahan, Jr.; Col. Ernest S. Barker; Col. Chester A. Carlsten; Col. Maurice P. Chadwick; Col. Carter W. Clarke; Col. Rex Van Den Corput, Jr.; Col. Eugene V. Elder; Col. Amory V. Eliot; Col. Walter C. Ellis; Col. Byron A. Falk; Col. Edward F. French; Col. Floyd T. Gillespie; Col. Paul C. Gripper; Col. Wesley T. Guest; Col. Elton F. Hammond; Col. Raymond C. Hildreth; Col. Tyree R. Horn; Col. William W. Jervey; Col. Emil Lenzner; Col. Reginald P. Lyman; Col. William M. Mack; Col. Thomas H. Maddocks; Col. Arthur E. Mickelson; Col. Paul L. Neal; Col. Donald H. Nelson; Col. James D. O'Connell; Col. Glenn H. Palmer; Col. Edwin R. Petzing; Col. Albert M. Pigg; Col. Arthur Pulsifier; Col. Robert W. Raynsford; Col. Harry Reichelderfer; Col. Leon H. Richmond; Col. Richard T. Schlosberg; Col. Howard W. Serig; Col. Charles M. Simpson, Jr.; Col. Benjamin Stern; Col. Louis S. Stickney; Col. Harry E. Storms; Col. Allen L. Stowell; Col. Louis J. Tatom; Col. Theodore T. Teague; Col. George L. Townsend; Col. Terrence J. Tully; Col. Marion Van Voorst; Col. Harry L. Vitzthum; Col. Percival A. Wakeman; Col. David E. Washburn; Col. Robert A. Willard; Col. George F. Wooley, Jr.; Lt. Col. Harold T. Gallagher.

Retired:

Colonel George L. Townsend, effective 31 January 1948.

Recent Overseas Assignments:

Colonel Merrill G. Beck, Far East Command, Yokohoma, Japan; Colonel Francis E. Kidwell, U. S. Army Group, American Mission for Aid to Greece.

Miscellaneous:
(all Washington, D. C.)

Colonel Stewart W. Stanley, The Adjutant General's Office Casuals; Colonel Walter C. Ellis, The Adjutant General's Office Casuals; Colonel James S. Willis, Student Detachment, National War College, Ft. McNair; Colonel Samuel P. Collins, Student Detachment, National War College, Ft. McNair; Colonel Murray D. Harris, Student Detachment, Industrial College of the Armed Forces, Ft. McNair; Colonel Eugene A. Kenny, Student Detachment, Industrial College of the Armed Forces, Ft. McNair.

Transfers:

Colonel Hugh Mitchell transferred from the Signal Corps to the U. S. Air Force.

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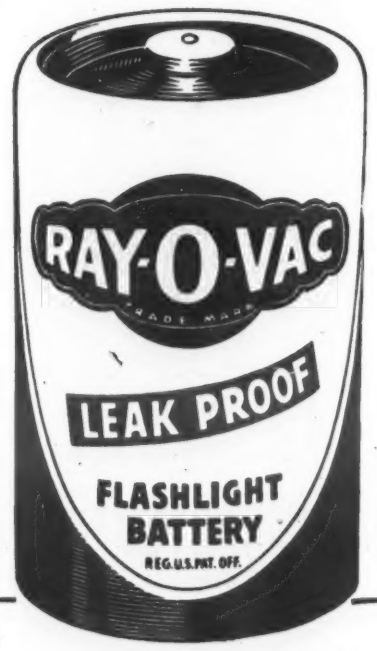

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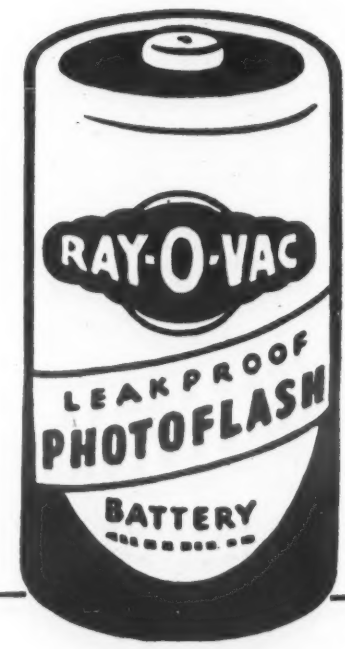

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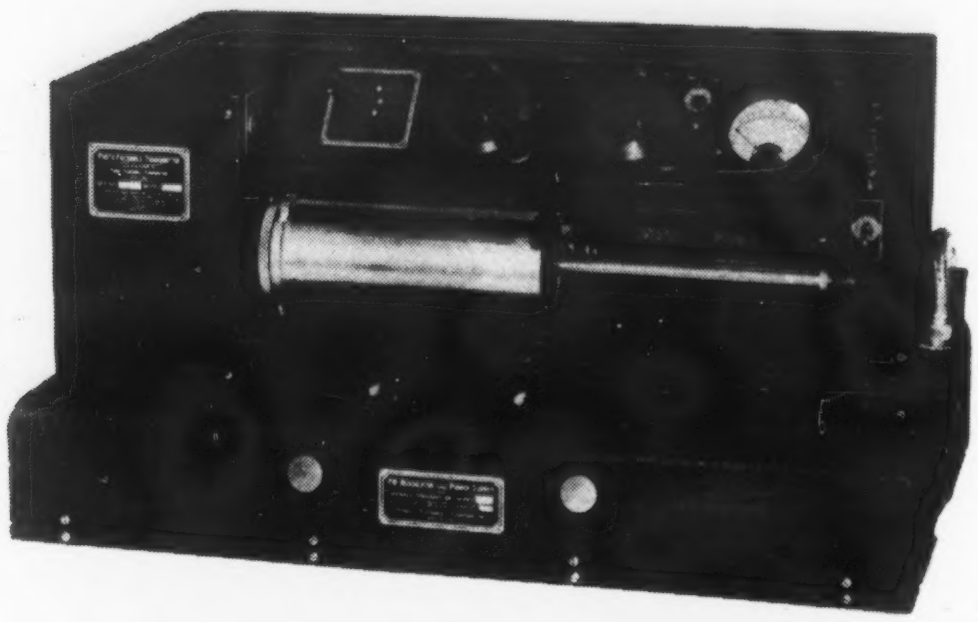

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